FEBRUARY 1, 1968 • VOL. 23 • NO. 1 • A SCHOLASTIC MAGAZINE

SENIOR SCIENCE

For Classes in Biology, Chemistry, Physics, Earth and Space Science

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CONTENTS

FEBRUARY 1, 1968 • VOL. 22, NO. 15

Features

How Fish Hear 2
by John Speicher

The Mystery of the Earth's Spin 5
by Thayer Willis

Critical Issues in Science 8
The I.Q. — Tool or Tyrant?
by Robert L. Wersan

Today's Scientists 10
Dr. Valentin Bonifas —
He Hunts Microbes

Science in the News 12

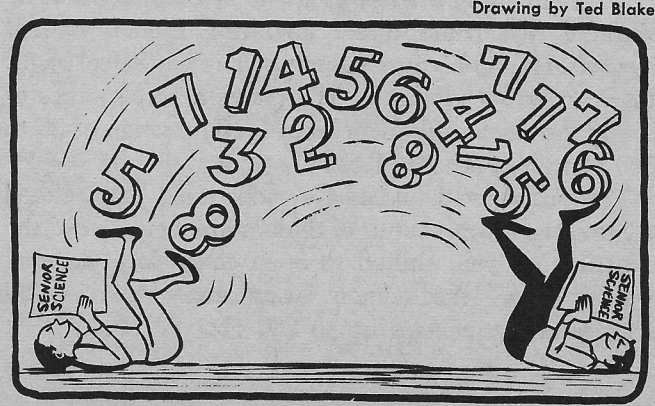
Departments

Project Pointers 14
Science Scoreboard 16
Index 17
Science on TV 19
Sports 20
Brain Teasers 21
DISCussions 22
Following the Films 23
Crossword Puzzle 24

Our Front Cover

With this first issue of the spring semester we present a brand-new feature: Critical Issues in Science. Periodically, we'll highlight those areas of controversy that have lively importance for scientists, policy-makers, and ordinary citizens alike. We hope these articles will show you how great an impact science has on your world, and how you can take an active part in dealing with both the problems and solutions of today's scientific research. We start with an issue you might not have suspected anyone was wrangling over — intelligence testing. Read all about the big I.Q. feud beginning on page 8.

Drawing by Ted Blake



Eusthenopteron, 350-million-year-old fossil fish in which man's middle ear structure may have originated.
Bell Labs & Amer. Mus. of Nat. History

HOW FISH HEAR

DR. JOHN G. VANDERWALKER, of the Columbia Fisheries Program, at Portland, Oregon, thinks that the "ear" of the salmon may rescue a threatened industry.

How? The great hydroelectric power dams on the Columbia River system are a boon to consumers of electricity. But they are deadly snares for *smolts*. These are young Chinook salmon, migrating from fresh-water "nurseries" in mountain streams to the Pacific Ocean — where they spend their adult lives. More and more young salmon are being killed off by turbine spillways and other hazards created by the dams. Thus the salmon fishing industry of the Pacific Northwest fears that salmon catches will decline drastically.

Dr. Vanderwalker feels that the salmon's hearing may save the day, however. Under his supervision, biologists of the Columbia Fisheries Program have devised a sonic warning that could direct migrating salmon *around hazards*. He and his associates rigged up large steel plates that can be set vibrating. The plates act as sources of sound, producing frequencies in the low range of 15 to 500 Hertz (cycles per second).

Tests conducted in tanks demonstrated that salmon try to escape from sounds of these frequencies. Next, the experiments were shifted to open channels of flowing water. There, the salmon swam away from sound sources at frequencies up to 280 Hz.

Columbia Fisheries researchers now plan to test similar low-frequency "warning signals" during migratorial rushes of seaward-bound smolts, when fish traffic in the rivers reaches a peak. Of course, there won't be any cloverleaf interchanges in the projected salmon freeway system. But should the "sonic steering" method prove successful, it will be yet another bonus from current research programs on the hearing of fish.

Already, Japanese scientists have successfully experimented with sounds as lures to increase fishing efficiency. Dr. Tomiju Hashimoto and Dr. Yoshinobu Maniwa, of the Ministry of Agriculture and Forestry, in Tokyo, Japan, discovered recently that schools of fish swimming in water produce sounds characteristic of their species. By recording and playing back fish sounds with underwater acoustical equipment, the researchers were able to attract fish of the same species.

Moreover, some fish were found to swim down and away rapidly when sounds of predators (such as the dolphin) were played. With such devices, Dr. Hashimoto and Dr. Maniwa drove schools of jack mackerel and barracuda into a big, set net. In other words, the fish caught themselves. What could be more desirable from a fisherman's point of view?

To the fishing industries of a protein-pinched world, the research into fish-hearing obviously holds great economic promise. But scientists are studying this subject

for other reasons, as well – with a variety of techniques.

Researchers point out that the hearing mechanism of mammals is complicated and difficult to investigate. They are therefore examining simple hearing organs, such as those of fish. They hope to gain from the uncomplicated fish hearing mechanisms an insight into the more complex mechanisms of higher animals, such as the little-understood *organ of corti* in man.

This tiny spiral organ, containing hair cells, is located in the cochlea in the inner-ear labyrinth. It is believed to be the chief, if not the only, means by which we perceive sound directly. Indeed, recent findings suggest that man's complex ear may actually have begun in rudimentary form in the fish.

For the most part, scientists use *conditioned learning* experiments to determine what sounds fish can hear. Investigators in the United States and the Soviet Union have led the way in the exploration of fish hearing by these methods.

Not long ago, Dr. William N. Tavolga, of the American Museum of Natural History, in New York, reported on a series of investigations conducted in collaboration with Dr. Jerome Wodinsky, a psychologist at Brandeis University, Waltham, Mass.

To test fish hearing, they decided to use a technique known as "avoidance conditioning," first developed with dogs as subjects by the renowned Russian psychologist I. P. Pavlov. Pavlov had conditioned dogs to raise a forepaw at the sound of a bell or the flash of a light. How? If the dog didn't raise the paw, Pavlov gave it a mild but irritating electric shock. Only by lifting its paw could the dog avoid getting a shock.

Dr. Tavolga and Dr. Wodinsky modified Pavlov's technique for fish. They designed a special "shuttle box." The "shuttle box" was a large aquarium separated into two compartments by a barrier. The barrier left just enough room at the top for the fish to swim back and forth between compartments. A sound source was hidden under the barrier.

The researchers conditioned a fish by sounding an "alarm" and then giving the fish a shock soon afterwards. Dr. Tavolga writes: "The fish learns to escape by crossing the barrier, because as soon as it does so both shock and sound are stopped." He points out that the time interval between shocks must be varied. If not, the fish learns to anticipate the shocks, regardless of whether it hears a sound or not!

Thus, by means of avoidance conditioning, the researchers trained fish to respond to a sound signal by shuttling across the barrier. Next, the scientists learned what sounds the fish heard, by varying the intensity and frequency of the sounds.

The experiments by Dr. Tavolga and Dr. Wodinsky confirmed that fish do indeed have the ability to detect sound and react to it. The majority of fish, Dr. Tavolga reports, have an upper hearing limit at frequencies of about 2,000 to 2,500 Hz – about two and one half octaves above middle C on the piano. Human beings can detect much higher frequencies – approaching 20,000 Hz. (Strict comparisons of human and fish hearing aren't meaningful, however, since water and air differ drastically as media for the propagation of sound. For instance, because of water's greater density, a given

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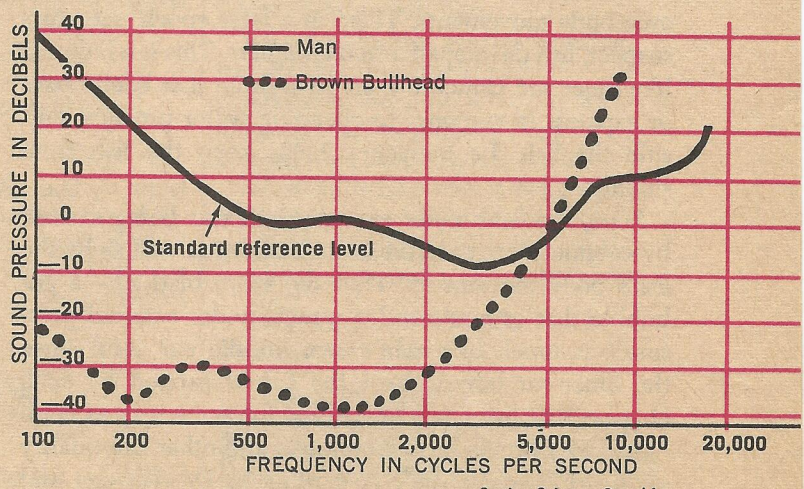
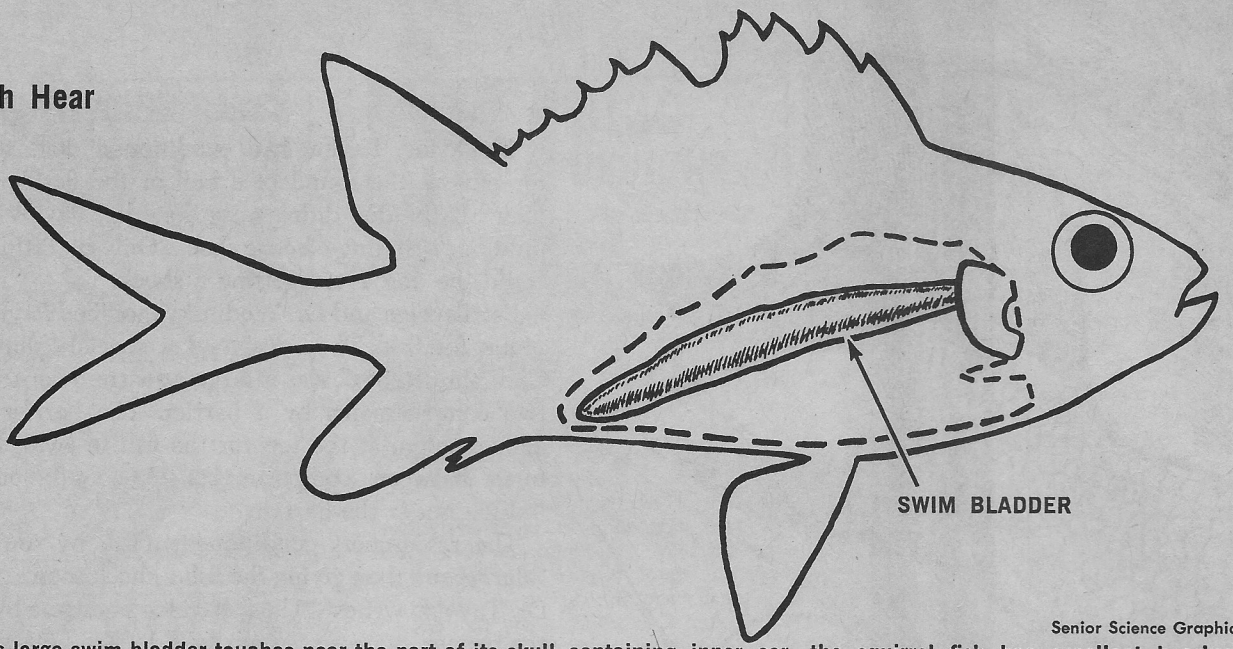


Senior Science Graphic

Areas below graph lines show frequencies and intensities inaudible to brown bullhead and man. Fish hears frequencies up to 5,000 Hz better than man, higher frequencies not so well.



Senior Science Graphic

Because its large swim bladder touches near the part of its skull containing inner ear, the squirrel fish has excellent hearing.

sound source produces pressures, or intensities, some 63 times greater in water than in air.)

The researchers found that a small group of fish species classify as "hearing specialists." That is, their hearing powers are much broader than those of most fish. These specialists include catfish, bullheads, carps, minnows, and eels. Certain minnows are thought to hear frequencies as high as 8,000 Hz. The hearing profile of the brown bullhead is diagrammed here, along with that of man.

How come the brown bullhead hears better than most other fish species?

Scientists have discovered that fish detect sound in two ways. Most fish possess tiny sensory organs buried in tubes and pits that extend in a thin line along each side of the body. Sensitive to water currents and motions, this hearing "organ" is called the *lateral line system.*

Scientists believe the lateral line evolved in primeval fishes. They think fish later evolved a labyrinth-like inner-ear structure that was, at first, sensitive only to the fish's own body movements. Then, in a later epoch, scientists suspect, fish developed a *swim bladder.* This is a balloon-like inner sac containing an air bubble that compresses or expands in response to changing water pressure outside the fish. Its buoyancy helps keep the fish from sinking.

Soon, the fish's inner-ear labyrinth was being excited by volume changes in the swim bladder as well as by the fish's body movements. Thus the swim bladder — a gas bubble that expands and contracts under external pressure — is much like man's own middle ear. And since the inner-ear labyrinth of the fish is excited by such changes, the fish hears in roughly the same way as man!

But why do the brown bullhead and other fish qualify as "hearing specialists"? According to Dr. Tavolga and other researchers, the bown bullhead has special bones that pick up and transmit vibrations from the swim bladder to the inner-ear labyrinth. These bones are similar in function to the anvil and stirrup bones of man. The squirrel fish, to take another example, lacks such bones. But it has a bigger than average swim bladder. The squirrel fish swim bladder lies very close to the part of its skull containing the inner-ear structure. Thus the brown bullhead and the squirrel fish have more acute hearing than most other fish.

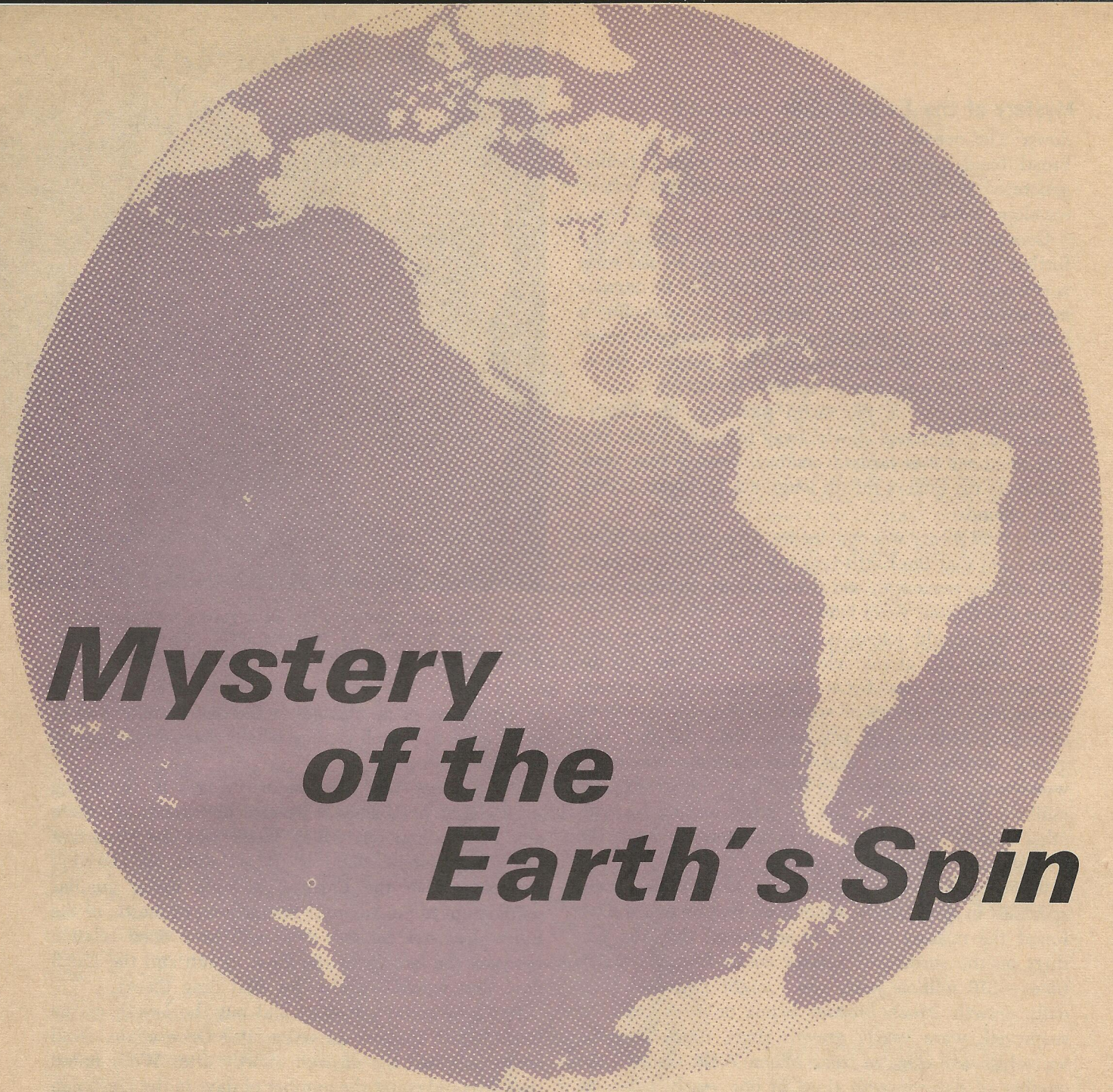
Dr. William A. van Bergeijk, of Bell Telephone Laboratories, recently reported evidence that a fossil fish, *Eusthenopteron,* may have possessed an eardrum-like structure. *Eusthenopteron,* a member of a family of ancient fish that are the suspected ancestors of amphibians, lived 350 million years ago.

Dr. van Bergeijk thinks that *Eusthenopteron* had an ear far superior to that of other early fish. He says the species had special pouches extending back from the mouth cavity. These were superior to the swim bladder as a middle ear, because their trapped air bubbles rested almost directly against the inner ear, and permitted directional hearing. (The location of an ear on either side of man's head accounts for man's ability to tell the origin of sound. But the single swim bladder of a fish cannot give directional information. Why not?)

Dr. van Bergeijk's studies suggest that *Eusthenopteron* had an eardrum that "consisted of a double-layered membrane between two bony shields in the head." He thinks this ancestor of the amphibians should have heard almost as well in air as in water.

Thus it seems likely that the human ear had its beginnings hundreds of millions of years ago in *Eusthenopteron,* or some other early fish. Researchers at the American Museum of Natural History, Bell Laboratories, and other institutions around the world will press the quest for more knowledge about the ears of men and fish. Their findings may bring practical applications not yet imagined.

— JOHN SPEICHER



Mystery of the Earth's Spin

EVER COMPLAIN that you can't squeeze everything into a 24-hour day? Then be glad you didn't live, say, 100 million years ago. Your day *then* would have been more than half an hour shorter than it is now. But to make up for the shorter day, you would have had more than a week and a half extra before the New Year rolled around – in all, about 375 days in the year.

Was the year really longer? No. It now takes the Earth the same amount of time – about 8,760 hours – as it did then to circle the sun completely. What *has* changed is the speed of the Earth's rotation. Slow the Earth's spin down and the days become longer and fewer. Speed it up and the days are shorter and more frequent.

How do we know the Earth is spinning more slowly? Using a giant "astronomical clock," astronomers calculate that the day is getting longer by about about 2/1,000ths of a second every 100 years. (If that does not sound very long, try multiplying it by one million centuries or so.) Tiny as it is, the change was detected by observing the relative motions of the sun, Mercury, and Venus. The astronomers found that the hands of the "clock" formed by the sun and the two planets were slowly forging ahead of the "hand" that daily rotated out from the Earth.

Recently, the invention of extremely accurate atomic clocks has confirmed this finding. The days today are indeed getting longer. But why?

Oddly enough, the reason was first suggested by a philosopher, not a scientist. In 1754, Immanuel Kant theorized that the Earth's tides might be slowing it

Continued on next page

Mystery of the Earth's Spin *continued*

down. The oceans, he said, tended to "heap up" in a broad band in the direction of the moon. Friction generated by the Earth spinning within this watery envelope would tend to act as a brake.

George H. Darwin, Charles Darwin's son, went a step further. He said that the friction produced by the tides is causing the Earth to steadily lose some of its *angular momentum,* the amount of energy in its spin. But a fundamental law of physics states that energy is never "lost." It must "go" somewhere. The energy is transferred to Earth's partner in space – the moon.

What happens as the moon picks up the Earth's momentum? It moves slowly away from the Earth at a rate of about five yards a century. During that same 100 years the moon's month lengthens by about 1/25th of a second.

The tidal theory was convincing. Using it, astronomers calculated that the Earth-year was 428 days long some 570 million years ago, and it was about 400 days long some 200 million years later.

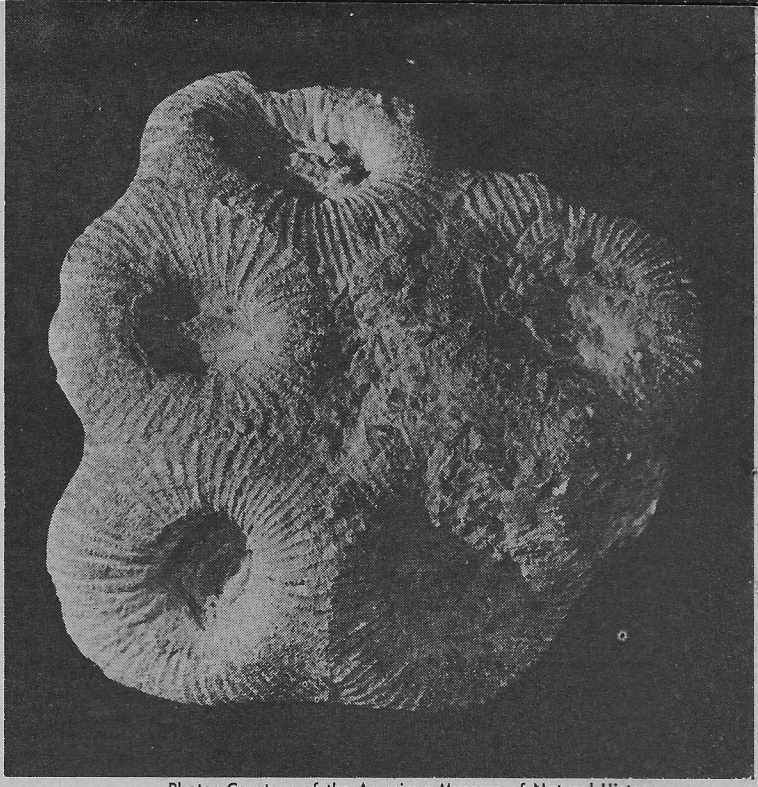
But how could scientists prove that the theory was true? After all, atomic clocks had been timing the increase in the day for a few years only. Accurate astronomical observations were available for just three centuries. Although it was clear that the day had grown longer during this short period, researchers wondered if the process had been going on steadily for millions of years. What the scientists needed was another "clock" that would let them double check the calendar millions of years ago.

Then, in 1963, John W. Wells, a Cornell University specialist in fossil corals, announced that he might have found the missing clock. He suggested that the *fine* rings on the surface of ancient corals from Devonian times – 370 million years ago – might represent their daily growth. Much *broader* bands on the corals, he suspected, were yearly growth rings, much like the annual growth rings in trees. When Wells counted the number of daily growth rings in one yearly band, he discovered about 400 of them – exactly the number of days predicted by the astronomers.

Was this firm proof that the tides were responsible for the slow-down in the Earth's rotation? Not at all. There is still another way for the Earth to have slowed its rotation. Wells's discovery did not rule it out.

Everyone knows that when a twirling skater pulls in his arms, he spins faster. Why? Because his *moment of inertia* – his mass multiplied by the square of the distance of his outthrust arms from his center – is decreasing. But the amount of energy in his spin must somehow be conserved. How? By increasing his rate of rotation, or spin.

If the Earth's moment of inertia changed, it would spin faster or slower, exactly like the skater. And this quantity could be altered by the Earth's contraction



Photos Courtesy of the American Museum of Natural History

Fossil corals like these have fine daily growth rings resembling yearly rings on trees. By counting them, scientists can tell number of days in year in ancient geological times.

or expansion, or by changes in the distribution of mass in its core. Any such change would therefore affect the length of the day.

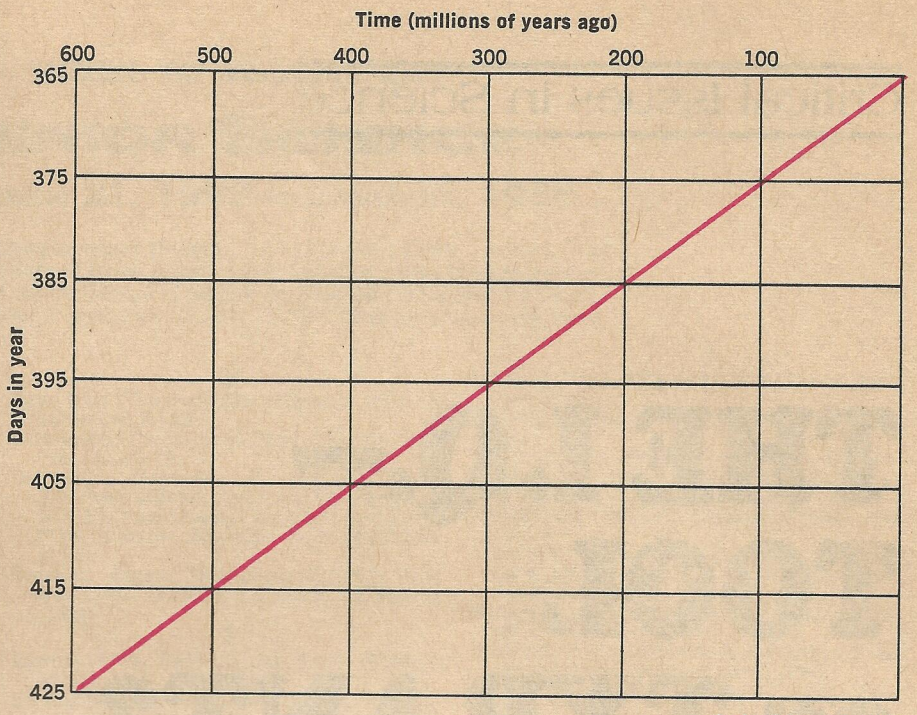
Thus, either tidal friction or changes in the Earth itself might have slowed its rate of rotation. Is there any way to find out which factor was the important one? Fortunately, there is. It is based on Darwin's suggestion that the Earth is steadily losing angular momentum to the moon. If the moment of inertia of the Earth *does not* change, there will be a fixed relation between the lengths of the lunar month and the Earth day. This would support the tidal drag theory.

But how could scientists find out the length of the lunar month millions of years ago? Once again, fossil corals supplied the answer. Shortly after Wells found that he could count the number of days in the Devonian year, Colin T. Scrutton of the British Museum made an equally important discovery. Dr. Scrutton discovered that he could count the days in *monthly* bands from corals of the same geological age.

Now Darwin's equation could be worked out. The result? The Earth's moment of inertia has changed by less than 0.5 per cent in the last 370 million years, a relatively insignificant amount. Tidal friction has thus been the principal factor affecting the Earth's rotation.

The discovery that the Earth's moment of inertia has been nearly unchanged for at least 370 million years is important to *geophysicists* studying the evolution of the Earth and the moon.

It was once thought that the Earth began as a molten blob. As it slowly cooled, it contracted. Mountains were thrust up like wrinkles on the shrinking skin of an old



Senior Science Graphic

Length of the year in various geological periods has been calculated by assuming that tidal friction is gradually slowing Earth's rotation, thus lengthening day.

apple. The process was thought to be a continuous one. But just as the skater spins faster as he pulls in his arms, so should the Earth spin faster as it contracts. We now know that this is not happening.

The Earth today has an iron core with a radius about half that of the entire planet. Dr. Harold C. Urey of the University of California has suggested that the Earth was once quite cold. All its iron was distributed evenly throughout the planet. Slowly, it sank to the center. This process would cause the Earth to rotate more rapidly, and the days, of course, would grow shorter.

These theories of the Earth's evolution require a gradually shortening day. Other theories, however, assume that the Earth has expanded, and that the day has thus grown longer. Giant cracks in the surface running through many of the oceans are held by these theories to have been the product of the expansion of a slowly heating Earth.

These various theories call for days with different lengths in distant geological periods. In Devonian time, the theories need days ranging in length from 12 hours to 24 hours and 40 minutes. When corals from other geological periods are studied, it may be possible to pinpoint exactly which theory is the correct one.

The corals will also help decipher the history of the moon. Knowing the rate at which the moon is withdrawing from the Earth by gaining angular momentum, we can calculate the Earth-moon distance at any time in the past.

When Dr. Louis B. Slichter of the University of California at Los Angeles attempted such calculations, he discovered that the moon should have been extremely close to the Earth about two billion years ago. But the Earth itself is about 4.5 billion years old. Where was the moon in the first 2.5 billion years of the Earth's history?

Perhaps, said scientists, tidal friction has been stronger in recent years, and is not typical of long geological periods. But evidence from the Devonian corals shows that tidal friction was about the same then as it is now.

Three highly speculative answers have been proposed for the moon's whereabouts two billion years ago. One holds that the moon was once a part of the Earth, that it broke away from what is now the Pacific Ocean, and that it came to rest in space nearby.

A second theory maintains that the moon once circled the Earth in a *retrograde*, or backward, orbit. In this situation, tidal friction would tend to draw the moon closer to the Earth. In time, the direction of the moon's orbit was reversed to its present path. Thus, two billion years ago, it began to move away.

A third theory is that the moon was formed in the vicinity of Earth by a "sweeping up" process. A small body revolving around Earth gradually gathered space dust and chunks of matter. As it became larger, it became more and more efficient as a "space vacuum cleaner," eventually forming a body the size of our moon. It became large enough to cause tides only two billion years ago.

Fossil corals may not be alone in helping to answer these questions. Certain 600-million-year-old fossil algae also show growth lines like those in corals. These primitive animals and plants may someday solve the riddle of the Earth's past.

— THAYER WILLIS

THE I.Q.— TOOL or TYRANT?

WHATS YOUR I.Q. SCORE?

Even if you know your I.Q. (Intelligence Quotient) — and according to the rules, you're not supposed to know it — what difference does it make?

According to some, an individual's I.Q. makes all the difference in the world, especially for his chances of success in following a chosen career. Yet, according to others, I.Q. scoring of students has done great injustice to many individuals. These authorities feel that the meaning of a single test score has been highly exaggerated.

I.Q. is supposed to be a scientific measurement. It was devised by scientists working in the field of *psychometrics* — mental measurement. Thus it is within the scope of scientists to question the scientific validity of I.Q. scores and the way in which they are used.

The use of I.Q. tests in the United States can be traced directly back to Dr. Lewis M. Terman (1877-1956), a psychologist and pioneer in psychometrics at Stanford University in California. Dr. Terman was the man who made the letters I.Q. part of the English language. He modified earlier French intelligence tests and adapted them for use with American children.

But it wasn't merely the tests themselves that established Dr. Terman's influence. His studies of gifted children — selected by means of I.Q. tests — set the pattern for today's general reliance on intelligence tests as predictors of academic ability. After an important study in 1927, Dr. Terman concluded that from the ranks of children making high intelligence test scores, "and from nowhere else, our geniuses in *every* line are recruited."

Today, it would be hard to find another psychologist as positive about the meaning of I.Q.'s. Moreover, recent research has shown that many children with average I.Q.'s place highest on tests and demonstrations of originality and creative thinking. One worker stated that if giftedness were defined only in terms of high intelligence, about 7 out of 10 of the most highly creative people in our society would be overlooked.

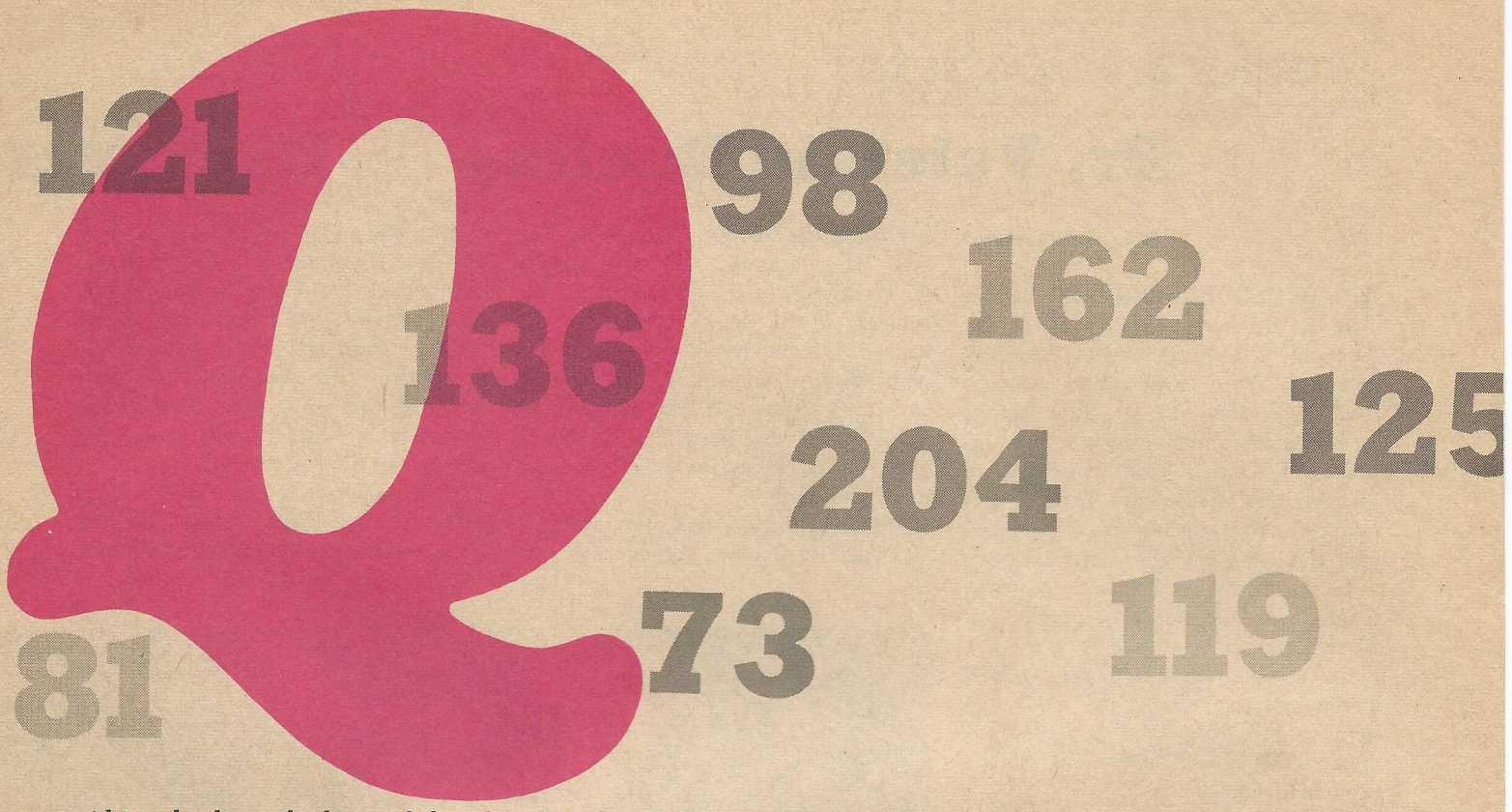
Yet, despite these and other criticisms (more of them later) of I.Q. testing, the practice is widespread. It has a great influence on American education. Why?

I.Q. tests are probably the best method developed *so far* for predicting success in school. The tests have the advantage of being standardized and convenient to administer. Most educational psychologists — even critics of I.Q. tests — tend to agree that I.Q. testing is a useful tool for evaluating students. But they object that many teachers, school administrators, and college admissions people place too much reliance on I.Q. scores. (So do students and parents, if they learn the scores.)

I.Q. tests are supposed to measure intelligence. The problem, according to their critics, is that no one has adequately defined exactly what intelligence is. They say that the tests mostly measure a person's ability to use words and to think in terms of language. These are known as *verbal* abilities. It is no wonder that a person's ability to do well in school can be measured by I.Q., say the critics. Why? Teaching and learning in schools is almost entirely done by means of language: reading, writing, and speaking.

What about the child who comes from a home where these verbal abilities are not valued or practiced — or a home where a language other than English is spoken?

By and large, it is the children of the poor, say the critics, who come from homes such as these. These children are often penalized by being grouped together



within schools on the basis of their low I.Q. scores.

To improve this situation, psychologists devised so-called "culture-free" tests. These were intended to eliminate the environmental (that is, "cultural") slant that previous I.Q. tests had, and so eliminate unfair penalties for children of lower verbal abilities. The new tests are based on pictures and design matching.

One critic of "culture-free" tests is Dr. David Wechsler, professor of clinical psychology at New York University Medical School, himself a designer of many I.Q. tests which bear his name. He asserts that, although culture-free tests may be useful in some situations, the results do not agree with conventional I.Q. tests. Moreover, they are poor predictors of over-all learning ability and of school achievement.

Dr. Wechsler says that conventional tests are themselves not unfair to poor and minority group children, but merely record the built-in unfairness of their situation in life.

I.Q. tests can also penalize other kinds of students. Take, for example, a potential engineer or scientist who happens to have low verbal abilities, and thus scores low on an I.Q. test. Such a person may well have other qualities – such as perseverance or the ability to design and make things – that are very important to a scientific career.

Consider the recent case of a 17-year-old Tulsa, Oklahoma, boy who has spent most of his life in a school for the mentally handicapped. He happened to be deaf. A school employee left a transistor radio kit on a work table. To his amazement, the boy assembled the radio with ease, merely by following the instructions and diagrams. It was only then that the boy's true abilities were suspected. He was transferred to a special school for the deaf, where his talents could be fully developed.

In another case, an Army recruit in Virginia was classified as a "clerk-typist" on the basis of test scores. Eventually, a university professor reached Army authorities and informed them that the young man was "the most outstanding mathematical genius I have encountered in years."

Some of the latest findings about I.Q. add still another dimension to the issue. Dr. Robert Rosenthal, a Harvard University social psychologist, and Dr. Lenore Jacobson, a San Francisco school principal, did the research. The researchers deliberately misled elementary school teachers, by telling them that I.Q. tests had shown that certain children would spurt ahead academically, whereas the children were actually picked at random. Nevertheless, the study showed that those children expected to make progress, did so!

In a forthcoming book reporting this research, Dr. Rosenthal says, "The difference between the special children and the ordinary children was only in the mind of the teacher. Children falsely labeled as potential spurters tended to bloom without any special tutoring or crash programs. The tests on which the findings were based were externally administered to avoid risk of favoritism. But it turned out that the teachers tended to grade their 'special' children more severely than their ordinary children, and spent less time babying them."

What is the future of I.Q. testing? More controversy is likely. Scientists can inform the public and attempt to give advice on practices such as I.Q. testing – practices that are no longer the property of researchers, but are in general use. But it is the public, hopefully well informed, that will have the last say on how the fruits of science are to be used. – Robert L. Wersan

today's scientists

Dr. Valentin Bonifas He Hunts

Bern, Switzerland

EARLY SEPTEMBER, 1965. Behind the frowning stone facade of the Institute of Hygiene at 51 Friedbühlstrasse in Bern, Switzerland, a tense drama was about to get underway. It had been set in motion by a severe outbreak of human food poisoning in Switzerland's Lake of Thun (pronounced *tune*) district, and had been caused by the eating of infected beef.

In the Institute's bacteria and virus diagnostic laboratory, a technician placed a drop of distilled water on a clean microscope slide; then, with a sterile platinum needle, he touched a germ culture that had been prepared from fluids taken from one of the poisoned victims.

The laboratory worker gently swirled the needle's tip in the water drop. After the drop had taken on a faint milky look, the technician picked up a fine, sterile glass rod, whose end had been bent into a triangle, and spread the whitish drop out into a film. He dried the film by holding the slide above a Bunsen burner, then rapidly passed the slide back and forth through the flame, "fixing" the film.

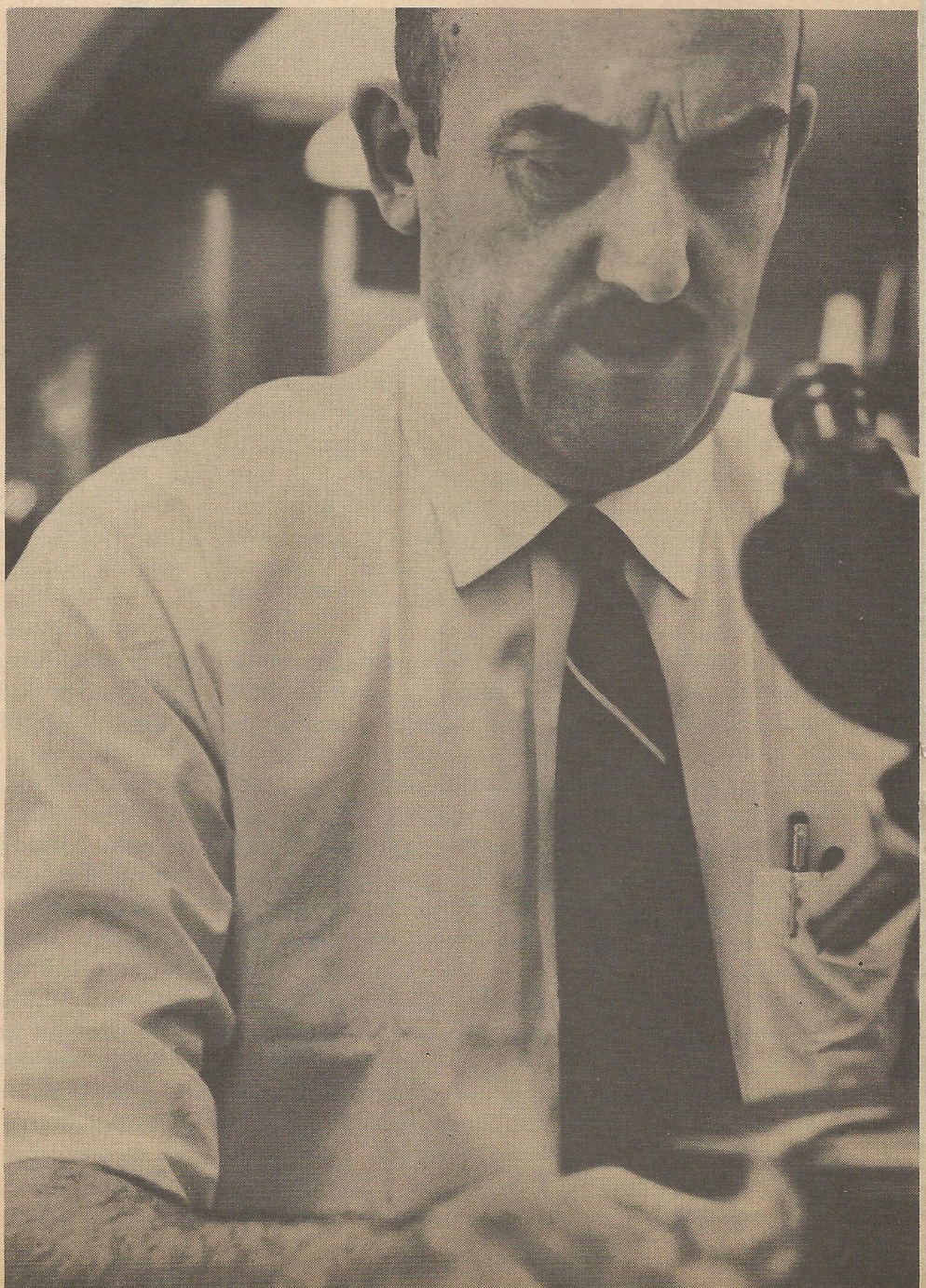
Now the aide was ready to perform a delicate laboratory procedure known as *gram-staining*, a technique that must be mastered by all who work with bacteria. The process is named for Hans C. J. Gram, a Danish bacteriologist who developed it in 1884.

Simply, the technique involves using dyes and washing agents on the slide-fixed bacteria. Some bacteria, when stained with the dye gentian violet, appear blue under a microscope. These bacteria are called *gram-positive*. Other bacteria, however, reject gentian violet, but will stain when treated with safranin, a red dye. These bacteria appear pink. They are called *gram-negative*. (For a complete explanation of gram-staining, see *Microbes and Men*, by Harold J. Simon, a Vistas of Science book published in 1963 by Scholastic Book Services.)

Bacteria that cause food poisoning are gram-negative. One such family of bacteria is *Salmonella*, named for an American pathologist, Daniel E. Salmon. He described the type species *S. choleraesuis*, which causes swine cholera. In the Swiss laboratory, the stained film on the slide was crowded with stubby, rod-shaped *Salmonella*, and further tests and type comparisons showed that these particular *Salmonella* were the microbes responsible for the food poisoning.

"The disease is called salmonellosis," Dr. Valentin Bonifas (pronounced *val-en-teen bon-ee-fah*) told *Senior Science*. The doctor, as director of the diagnostic laboratory in Bern, and as a microbiologist, became instrumental in stopping the food poisoning before it raged into an epidemic. He was joined by many Swiss doctors – not only M.D.'s, but doctors of veterinary medicine, and scientists with Ph.D.'s, as well.

"Salmonellosis is an international problem," Dr. Bonifas said, "because of the movement of foods across borders.



Microbes

In our case in 1965, a farmer undoubtedly fed his cattle imported feed hay – in which *Salmonella* were present. Suddenly, one of the cattle got sick. Its feces spread the germs to other cattle. Only the farmer knew his cattle were sick. He butchered one or more and sold the meat on the black market – without government inspection. Some of the persons who ate the meat became seriously ill and had to be hospitalized. But others, although they didn't become very sick, nevertheless became disease carriers."

Photo by Melvin Miller

In summer in Switzerland, cattle move into the high Alps to graze on grass-filled meadows above the timberline. "Since the cattle were there, we had to go there, too. We had to investigate on the spot. Also, if the alpine regions became infected, it would mean the milk would have to be barred. Fortunately, we knew the general locale of the outbreak – the mountains rising above the Lake of Thun."

Dr. Bonifas and his fellow disease detectives broke up into teams, and swarmed onto the Alps. They were to ascend as high as 6,500 feet. "We got around in Jeeps, but it was a complicated business, and map reading had to go into our work. And those mountains! As soon as you get on them – boy! Up and down, up and down."

Clouds rubbed across the alpine meadows, and now and then heavy rains drenched the teams, an ominous warning that the disease had to be stamped out quickly, or the rains would help spread the outbreak even further. Veterinarians took swabs from cattle and hurried them to a field laboratory, set up in a military barracks, for tests. The temporary lab was swamped with work, so test specimens had to be rushed to university laboratories outside the district. More than 3,000 cattle were examined.

"In this test," Dr. Bonifas explained, "we used a broth culture first. This was an enrichment broth that depressed the growth of colon bacteria, normally found in the intestines, but sped up the growth of bacteria such as *Salmonella*. This is done to isolate the disease-causing bacteria from the other microbes. Then we tested the isolated strain with a type serum that agglutinized *Salmonella*. And we had to do this for each animal."

Here is how the test worked: Test tubes containing *sera*, the fluid part of blood, from immunized swine were prepared. Such serum contains *antibodies*, which are substances released into the watery part of the blood when bacteria or their poisons are present. Antibodies "fight" disease germs and their toxins. Isolated bacteria from each cow were then placed in the test tubes, and a careful record was kept so the cow being tested would be known. If the isolated bacilli fell to the bottom of the tube in a clump – indicating they had been agglutinized by the attacking antibodies – the tester knew he had found a cow infected with *Salmonella*.

"Our search took ten days," Dr. Bonifas said. "We found several infected herds. Treatment was simple – antibiotics were used. Happily, no person died from the food poisoning, and carriers were tracked down by private physicians and treated."

Dr. Bonifas hopes his country will soon enact a law requiring importers to prove that foods brought in from outside Switzerland for either human or livestock consumption are disease-free. Then, with a wry smile, he said, "There are more than 600 types of *Salmonella*, almost an impossible situation."

Dr. Bonifas became a scientist in a roundabout way. His degree states that he is an M.D., a medical doctor. "But during my first year at the University of Geneva, my teachers instilled in me an urge to do research. *They made me work.* I wanted to study medicine and physics, and I became interested in the medical aspects of biological phenomena. I have a love for both biology and the exact sciences – physics and measurement. So, although I studied for an M.D. degree, I very rapidly decided I wanted to go into the scientific aspects of medicine, and so went into microbiology."

After his studies were complete, however, Dr. Bonifas did practice medicine for a time. He became a resident in a clinic, then for a year was a state medical assistant. "But I realized it wasn't for me." Dr. Bonifas accepted a position with the Institute of Microbiology at his *alma mater*, and there started an electron microscopy center. In 1963, he went to Bern. Now respected and admired in Europe and the United States for his research skill and insight into microbiologic problems, Dr. Bonifas recently ended a tour of the U.S., during which time he was a guest at several major universities.

There is more communication between teachers and students in the United States, he observed, than in Europe. European medical teachers are traditionaly out-of-reach of their students, who do not often get a chance to ask questions. Dr. Bonifas believes science teachers should do research. "Teaching is reinforced by research – it keeps the intellect alert."

— Fred Brewer

SCIENCE IN THE NEWS

AAAS Meeting

The final week of the year brings together thousands of scientists for the annual meeting of the American Association for the Advancement of Science.

This week's "Science in the News" covers some of the highlights of the meeting.

"City of the Future" Described

Our cities are plagued with problems. Crowding, dirty air, traffic jams, shabby slums, and overworked utilities are just a few of them. How do we cope with these problems? Most people say "repair the damage through *urban renewal*." But Dr. Athelstan Spilhaus, president of the Franklin Institute of Philadelphia, strongly disagrees. Addressing the American Association for the Advancement of Science, he proposed that we knock down the worn-out parts of our present cities and build brand new ultra-modern cities in the uncrowded parts of the country.

Dr. Spilhaus intends to build such a city in Minnesota. Designed to house 250,000 people, this city would be run like a great hotel. The city and 40,000 acres of open land around it would be owned by a single corporation. Air pollution would be prevented by piping fumes to an underground air-cleaning plant. Underground roads and railways would keep traffic off the streets. High-rise apartment dwellings would group the population close together and close to their places of work. Yet nature would be nearby in the open land around the city, which would be kept free of suburbs.

Lawless Frontier

Scientists fear that the world's newest frontier — the oceans — will be a lawless "no man's land." The oceans are vast sources of international conflicts as well as new resources, said experts at the annual meeting of the American Association for the Advancement of Science.

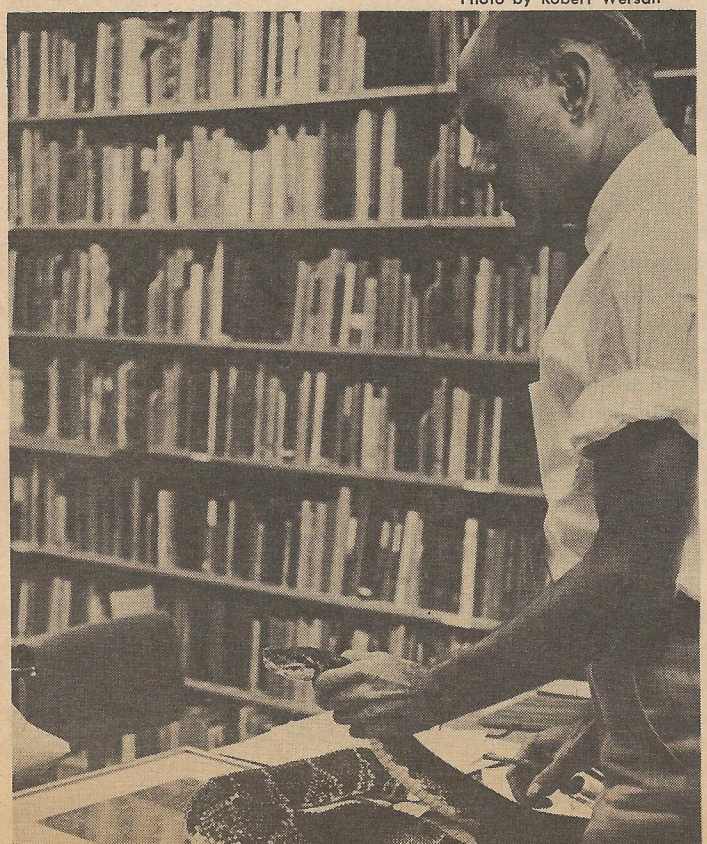
While man has ensured the peaceful uses of outer space and the Earth's polar regions, there are no such international agreements for harvesting the mineral wealth of the oceans, said Herman Pollack, State Department science advisor. Senator Claiborne Pell, Democrat of Rhode Island, called for a compromise between the present "finders-keepers" rule and a United Nations proposal. The U.N. has asked for ocean profits to be spent in under-developed countries.

Fail-safe Silk Glands?

Experiments suggest a spider knows how much silk protein it has available in its body for the construction of a web. So reports Dr. David Peakall of Upstate Medical Center, in Syracuse, N. Y.

In one experiment, scientists attached weights to the backs of spiders. The creatures spun webs with unusually thick threads (apparently to support their added weight). But the total length of the extra-thick threads was shorter, thus saving on the silk. In

Bushmaster—world's deadliest snake—visits our science offices. Contributing editor Kenneth Bobrowsky displays a ten-foot bushmaster he caught on field trip to Panamanian jungles.
Photo by Robert Wersan



Waiting to be coaxed a little more, Dah Miri, a two-year-old takin, gets an apple from her keeper at the Bronx Zoo. Found in Bhutan, she is one of four of these rare animals in the U. S.
Photo from UPI

Photo from UPI

A tiny measuring device and its transmitter can now be implanted in the human heart to record blood pressure continuously. Inventor, Grant W. Coon of NASA, holds the new instrument.

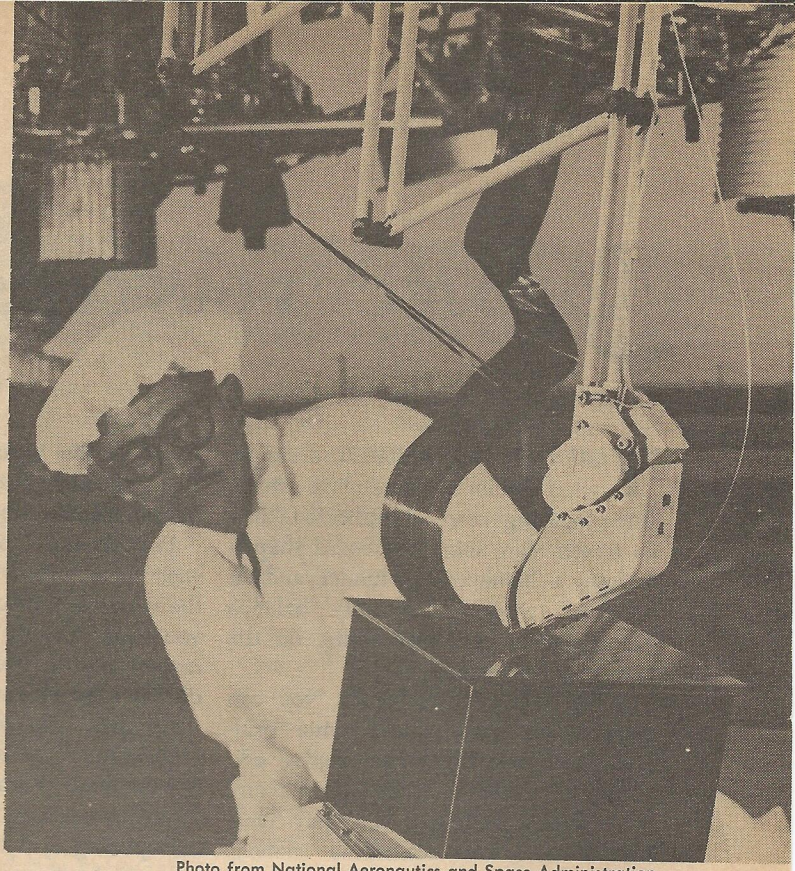


Photo from National Aeronautics and Space Administration

This gold-plated box clutched in the metal claw of Surveyor 7 may unlock the mystery of the moon's origin. Using radioactive particles, it will analyze moon "soil" dug by the claw.

another test, sections of a web under construction were continually burned away. At first, the spider respun these sections, then gave up and finished the web without them. Dr. Peakall comments: "It is obviously very useful for the spider to be able to tailor its web-building to the supply of silk available."

Birth of Stars

How are stars born?

Astrophysicists generally agree that the birth of a star begins when hydrogen atoms floating freely in space are drawn together into clouds by the force of their own gravitational attraction. Where the clusters of atoms become particularly dense, the terrific heat produced causes the atoms to begin to fuse — combine to make heavier atoms. During the fusion process, huge amounts of energy are released. The energy emitted by stars is very similar to that of a modern hydrogen bomb blast.

There has always been one weakness in this concept of star formation. The hydrogen gas atoms in space are so thinly spread out that their gravitational attraction seems too weak to pull them together into dense clouds. Now Dr. Eugene N. Parker, a professor of physics at the University of Chicago, has come up with some fresh thinking that may shore up the weak spot in the concept.

Astrophysicists have long known that cosmic rays — high-energy electrical particles — stream through space. Recent laboratory cosmic ray research and cosmic ray observations from balloon, satellite, and space probes have turned up some interesting facts. The research suggests that cosmic rays cause magnetic fields in space to warp and fold into an uneven terrain of tall "peaks" and deep "troughs." Dr. Parker theorizes that the electrically charged hydrogen particles, following the outlines of this magnetic terrain, collect in the "deep troughs." Thus, in the magnetic troughs, sufficient hydrogen atoms would accumulate, over millions of years, to start the birth process of stars.

According to Dr. Parker's calculations, such troughs should exist in space, separated by about 300 light years. So far, astronomical measurements of the distances between large gas clouds seem to confirm Dr. Parker's theory.

Is There Intelligent Life on Earth?

Dr. Lamont C. Cole, a biologist at Cornell University, wonders whether there is intelligent life on Earth. Why? He believes that, through ignorance, man may literally burn up the Earth's supply of oxygen.

The burning of fossil fuels — coal and oil — causes carbon in the fuels to combine with oxygen in the atmosphere. The chemical reaction produces carbon dioxide. We know, of course, that carbon dioxide is used by green plants to manufacture oxygen in the presence of sunlight. However, our mushrooming cities and industries are crowding out plants and trees.

Dr. Cole is also concerned over the fate of plant life in the oceans. These are estimated to produce 70 per cent of the Earth's oxygen supply. These living things are in danger of becoming poisoned by pesticides and detergents that find their way into the oceans.

Another warning was sounded by Dr. Barry Commoner of Washington University in St. Louis. The use of chemical fertilizers, he stated, can also boomerang. Inorganic nitrate fertilizers have polluted rivers and farmland. This has pushed up the nitrate content of the foods we eat. Dr. Commoner cited recent chemical analyses of baby food that showed 40 milligrams of nitrogen in the form of nitrate per two-ounce jar. Is this harmful?

"Public health officials recommend that infants take, in their food and water, no more than 12 milligrams of nitrate nitrogen per day," said Dr. Commoner. Excessive amounts of nitrate nitrogen can affect a baby's growth and development. Along with Dr. Cole, Dr. Commoner suggests that others start worrying too — and take action.

PROJECT POINTERS

A Small Wind Tunnel

YOU CAN CONSTRUCT a simple wind tunnel at home or in school, using nothing more complicated than an electric fan, some cardboard shaped to form a "honeycomb" tunnel, and an ordinary two-pan laboratory balance (to measure the forces acting on the wings to be tested).

With such a wind tunnel, you can demonstrate basic aerodynamic principles and investigate the relative efficiency of different wing sections and other lifting surfaces. You may have friends who can contribute sections from the wings of crashed model airplanes. Or, you may know a model airplane hobbyist who would like to work with you and build wing sections especially for your project — thus adding some basic laboratory know-how to his practical background.

In addition to the equipment mentioned above, you will need such items as single-edged razor blades, pieces of scrap sheet metal, and wooden dowel sticks.

Start by setting up the fan and honeycomb tunnel, as shown in Fig. 1. The box may be cardboard or wood. Make the honeycomb itself by gluing together layers of accordion-pleated cardboard or manila folders. The honeycomb is needed to reduce turbulence.

Remove the metal pans from the balance and replace them with two identical circular disks of wood. Drill a hole in the center of one wooden disk to accommodate a length of dowel stick.

Fasten an ordinary ringstand clamp to the dowel (see Fig. 1). This clamp will serve as part of the "drag rod." Use a triangular file to cut two V-shaped notches opposite each other in the top of the jaws of the clamp (see Fig. 2).

Fit another dowel stick with two single-edged razor blades, as shown in Fig. 2. Secure the blades to the dowel stick with model airplane cement or other adhesive. Mount the upper razor blade about halfway up the dowel, with the cutting edge down, so that it rests freely in the V-notches in the clamp. Thus, the dowel stick will balance on the pivot formed by the razor's edge.

Provide the top of the dowel stick with some sort of device for attaching the wing sections or model aircraft that you plan to test. Fasten the second razor blade to the bottom end of the dowel, edge upward (see Fig. 2).

Another, very short, dowel hangs from a sheet-metal collar that pivots on the bottom blade. Form the collar as shown. Note the opening on each side. Shape the opening by first drilling through the two metal prongs, then using a triangular file to cut a long V-notch in the top of each hole. These notches pivot on the edge of the bottom razor blade.

Finally, fasten a sheet-metal pointer to the lower end of the short dowel. Attach a piece of cardboard behind the pointer to serve as a scale (see calibration instructions below).

To start your investigations, mount a wing section on top of the drag rod. Add weights or pieces of metal to the right-hand balance pan until the balance is level. Now turn on the fan. What happens?

To measure the lift produced, add weights to the left-hand balance pan (or move the sliding scale), until the setup returns to a steady, balanced position in the airstream. The amount of weight required equals the lift exerted on the wing section.

The angle of attack may be measured with an ordinary protractor (see Fig. 1). Wait until the system comes to rest in the moving stream of air before reading off the angle of attack.

Alter the angle of attack of the wing. How does this affect the amount of lift? What is the lift per square inch? (To find this, divide the measured lift by the area of the wing.)

You will have to calibrate the drag indicator before you can determine the amount of drag. Connect a thin string so that it runs from the wing and over a small pulley placed at the top of the dowel fastened to the balance (see Fig. 3). Hang a tiny paper bag from the free end of the string.

Turn on the fan. As the wing lifts up, the drag rod connected to it tilts backwards, thus moving the pointer along the cardboard drag scale. As the angle of attack is varied during calibration, move the pulley up and down as needed to keep the string between airfoil and pulley always parallel to the airstream (horizontal).

Add fractional gram weights to the paper bag, one at a time. Mark and label the cardboard scale at the point associated with each particular weight. Your drag indicator is now calibrated; it reads drag in grams.

Always wait until the apparatus reaches a steady position in the airstream before measuring angle of attack, lift, and drag. Change the angle of attack in steps of two degrees, to get a complete set of data for each test.

What happens to drag and lift as the angle of attack increases? If you have a variable-speed fan, you may be intrigued by the effect of different airspeeds upon the drag force. For example, what happens to the amount of drag if the airspeed is doubled? (Hint: It does not merely double.)

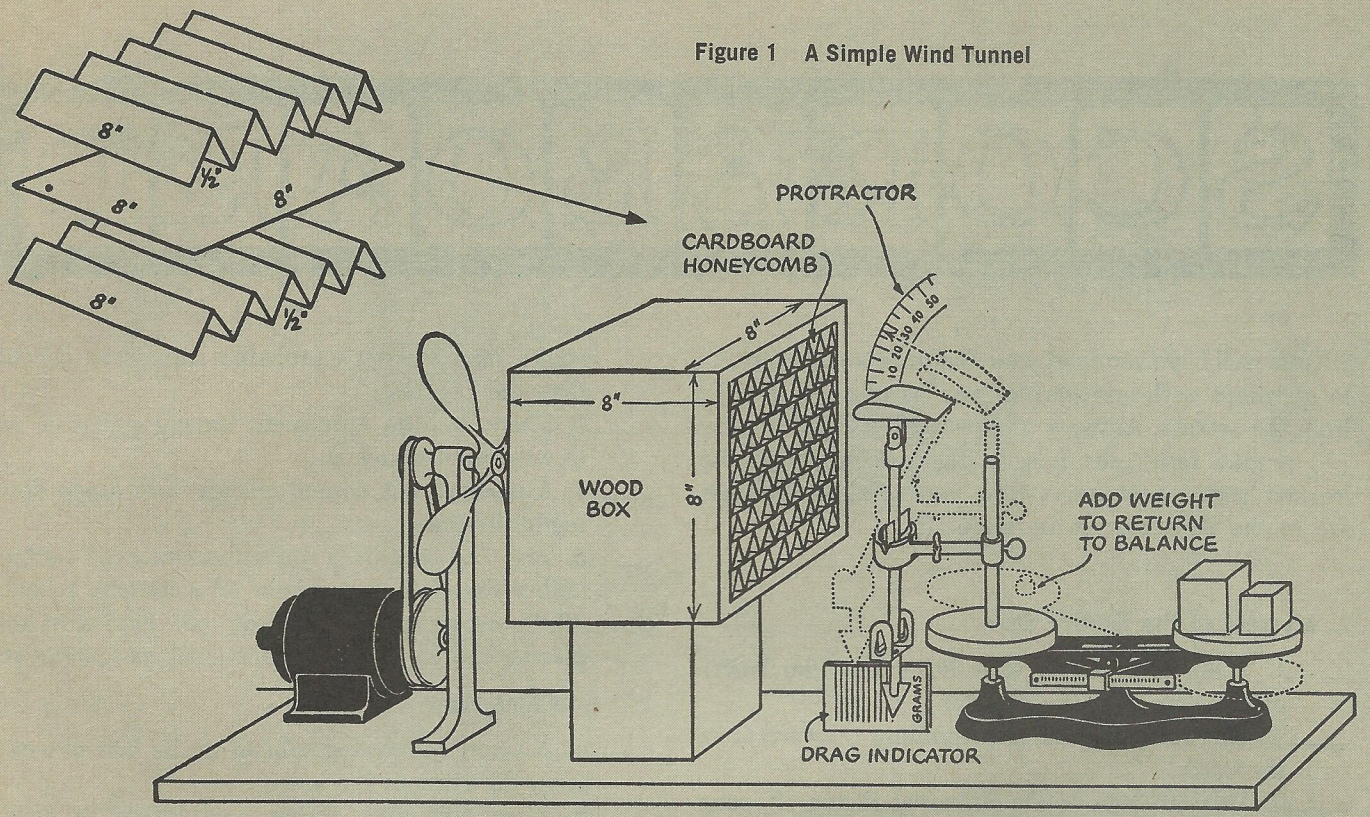
Compare drag and lift in different shapes of wings. You are not restricted to wing sections; lift and drag can be measured for entire model airplanes, or for any lifting surface.

The National Aeronautics and Space Administration is testing "lifting bodies" — wingless craft whose very bodies are designed to produce lift. Perhaps you would like to try designing and testing some yourself.

To interpret your results, you may find it useful to plot curves of your data for easy comparison. For example, you can plot the angle of attack, in degrees, against the amount of drag (D) or lift (L). The angle of attack is generally plotted on the x axis, with the drag or lift indicated on the y axis. You can also calculate and plot the curves for the ratios L/D and D/L.

— ALEXANDER JOSEPH

Figure 1 A Simple Wind Tunnel



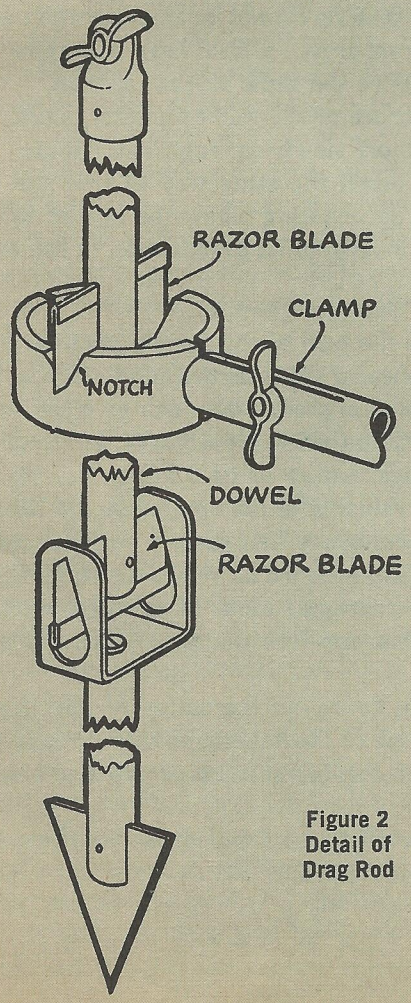


Figure 2
Detail of
Drag Rod

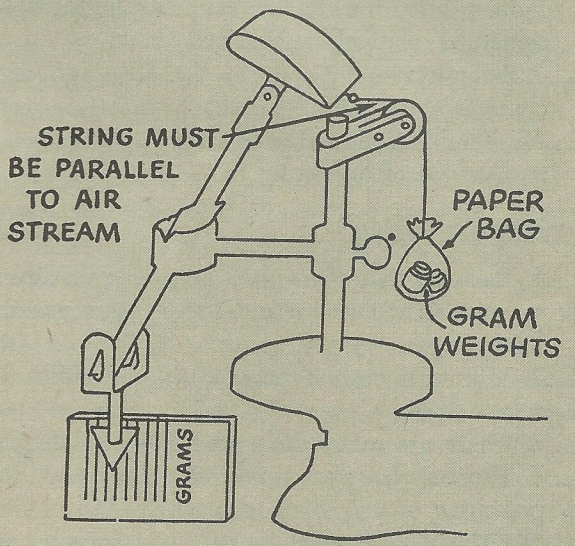


Figure 3 Calibrating the Drag Indicator

Drawings by Anastasia Joseph Hayes

SCOREBOARD

How well have you read your *Senior Science*? Answers to questions with no asterisks may be gleaned directly from the articles. Answers to questions with an asterisk (*) require fusing the facts in the articles with those learned in the classroom or from your reading. Answers are in the SCOREKEEPER on page 23.

I. Mystery of the Earth's Spin

_____1. There is evidence to indicate that the length of the day is getting shorter.
_____2. The moon is gradually spiraling outward from the Earth.
_____3. Tidal friction is the principal factor affecting the rate of the Earth's rotation.
_____4. Evidence from Devonian corals shows that tidal friction has markedly changed from year to year.
_____5. The fact that the Earth's moment of inertia has changed very little over the past 800 million years indicates that the size and shape of the Earth have remained relatively unchanged.
_____6. Scientists today believe that the age of the Earth is about 4.5 billion years.
_____*7. Doubling the radius of a solid sphere increases its moment of inertia by four.

II. Today's Scientists

_____1. Bacteria that cause food poisoning readily take up gentian violet dye and appear blue under the microscope.
_____2. Milk from cows infected with *Salmonella* is unsafe to drink.
_____3. There are many different types of *Salmonella.*
_____4. Human beings cannot develop immunity to food poisoning of the *Salmonella* type.
_____*5. The quick development of symptoms as a result of meat poisoning is due largely to the toxins produced by the infecting organism.

III. Critical Issues in Science

_____1. Research has shown that many children with average I.Q.'s place highest on tests of originality and creative thinking.
_____2. The "culturally independent" tests are a better gauge of a student's probable success in school than the I.Q. test.
_____3. There is little agreement among scientists as to what intelligence is.
_____4. A person's I.Q. cannot change very much during his lifetime.
_____5. The I.Q. test is a better measure of verbal ability than it is a predictor of success in school.
_____*6. Tests of specific abilities are gradually replacing the I.Q. test in educational measurement.

IV. How Fish Hear

_____1. A smolt is a young salmon on its first descent from the river to the sea.
_____2. After swimming upriver and laying its eggs, the adult salmon swims back to the ocean until the the next breeding season.
_____3. Sounds whose frequencies are in the range of 15 to 500 Hertz cannot be heard by the human ear.
_____4. The majority of fish have an upper hearing limit about the same as that of man.
_____*5. Because of the water's greater density, sounds travel more slowly in water than in air.
_____*6. In much the same way as tree age is determined by counting rings, the age of fish can be determined from an examination of fish ear bones.

Going Beyond

Ever since the turn of the century, the use of Gram's staining has been a valuable tool in identifying bacteria. Many such staining techniques can give the bacteriologist clues both to the identification of the bacterium and to the chemical nature of its coating.

One such valuable test is applied to the bacillus that causes tuberculosis. When stained with an aniline dye such as fuchsin, such bacilli retain the stain, even when treated with strong solutions of sulfuric or nitric acid. Most other bacteria lose the stain when placed in the acid.

1. Can you figure out the nature of the substance of which the coat of the tuberculosis bacterium is made? (Hint: What organic substances are not attacked by acids?)

2. Explain why even dried sputum can be a source of tuberculosis infection.

INDEX TO VOLUME 22

SENIOR SCIENCE

SEPTEMBER 21, 1967 — JANUARY, 1968

Note: Letters indicate month (S-Sept., O-Oct., N-Nov., D-Dec., J-Jan.). First figure indicates date of issue. Number after the dash refers to page number. Example: S21-4 means Sept. 21, page 4. An asterisk * indicates major article, (bio) indicates biographical sketch, (N) indicates Science in the News.

A

Accidents: *The Accident Plague (Samuel F. O'Gorman) O19-6.
Air Pollution: Smog Treatment Centers (N) D7-17.
Air Waves: *Waves in the Air (diagrams, John Speicher) D7-6.
Airports: Chemical Tested to Clear Fog (N) D7-17.
Animals: see also **specific animal.** *Animals in Motion (Simon Dresner) J18-4.
Antarctic: Walton's Report (N) N9-12; Climate (N) N9-13.
Antibodies: *Antibodies Lock and Key (John Speicher) N2-11.
Aquanauts: *Man Under the Sea (John Speicher) O19-2.
Archaeology: Atlantis Found? (N) S21-18.
Asthma: Roaches and Asthma (N) O5-19.
Astronomy: 1970 Eclipse to be Tracked by Plane (N) O26-16.
Atmospheric Pressure: *Search for the Perfect Vacuum (diagram, Robert Wersan) O5-8.
Atoms: *Phosphorus—Lethal Atom (diagram, Michael Cusack & Carl Proujan) N16-13.
Atomic Particles: Mica and Neutrinos (N) N2-15.
Atomic Power: 25th Birthday (N) D14-12.
Atomic Tests: Project Gasbuggy (N) O26-16.
Aviation: Foam Fuel Tank Used in Vietnam (N) O19-12.

B

Balloons: Project Stratoscope (N) D14-13.
Bees: Pesticides Danger (N) N9-13.
Bethe, Dr. Hans Albrecht: Nobel Physics Award (N) N30-17.
Biological Clocks: *How We Tell Time (diagram, John Speicher) S21-10.
Birds: see also **specific bird.** Whooping Crane Count (N) D7-17.
Blood: Fighting Clots (N) D14-12.

C

Cells: *Hybrid Cells (Robert Wersan) S21-13.
Circulation: *What Is Death? (Thayer Willis) N9-5.
Climatology: (Special Issue). *Climates of the Past (diagram, John Speicher) O26-6; *Currents and Climates (diagram, Donald Sanders) O26-11; *Climates of Tomorrow (Michael Cusack) O26-13.
Coal: Sound Waves Used to Break Down Coal (N) D7-17.
Cockroaches: Roaches and Asthma (N) O5-19.
Conservation: Everglades, Rampart Dam (N) S21-19.
Continental Drift: Drifting Continents (N) S28-20: New Project (N) O19-13.
Corn: High in Protein (N) O19-13.
Covers: Watches S21; Volcanoes S28; Outer Space O5; Starfish O12; Men Under Water O19; Jamaica O26; Surfer N2; Blackout N9; Porcupine N16; Plate with Frozen Milk N30; Wave Clouds D7; Tarantula D14; Mosquito J11; Herring Gull J18.
Cryogenics: *The Deep Freeze—Absolute Zero (diagram, Raphael Gatti) D14-9.
Cusack, Michael: *Harder Than Diamonds? (diagram) O5-12; *Why Moons? O12-7; *Na & K—The Alkali Twins (diagram) O19-9; *Climates of Tomorrow O26-13; *Power Blackout (diagram) N9-2; *Phosphorus—Lethal Atom (diagram) N16-13; *Electrostatics D7-13; *One Hundred Years of Helium J11-8; *Superconducting Magnets J18-11.

D

Dead Sea: *The Dead Sea (diagrams, Jacques Simmons) N16-6.
Diamonds: *Harder Than Diamonds? (Michael Cusack) O5-12.
Diseases: *Harvest of Hunger (John Speicher) S28-16; Asian Flu Epidemic (N) N16-19; New Mumps Vaccine (N) N30-17; *The Malaria Menace (John Speicher) J11-2.
Dresner, Simon: *Volcanoes S28-12; *Big and Little N30-10; *Animals in Motion J18-4.

E

Earths: *The Rare Earths (Carl Proujan) N30-8.
Earthquakes: In Turkey (N) S21-18; Predicting (N) N2-14; Fewer Great Quakes (N) N9-13.
Ecology: *Feedback (diagram, Jacques Simmons) S21-6; *Rats (Thayer Willis) S28-8; *Poisons in Nature (John Speicher) D14-4.
Echinoderms: *Sea Creatures with Spiny Skins (Robert Wersan) O12-10.
Eigen, Dr. Manfred: Nobel Chemistry Award (N) N30-17.
Electricity: *Power Blackout (Michael Cusack) N9-2; *Electrostatics (Michael Cusack) D7-13; *Superconducting Magnets (Michael Cusack) J18-11.
Elements: Na & K—The Alkaili Twins (diagram, Michael Cusack) O19-9; *One Hundred Years of Helium (Michael Cusack) J11-8.
Erosion: *Climates of Tomorrow (Michael Cusack) O26-13.
Everglades: Conservation (N) S21-19.

F

Fish: Sealab Menace, Poison Fish (N) O12-15.
Fog: Chemical Tested to Clean Airports (N) D7-17.
Foods: *Harvest of Hunger (John Speicher) S28-16; Artificial Sweeteners (N) N9-13.
Fossils: Ants (N) S28-20.
Friction: Rolamite (N) N30-16.
Fruit Flies: Carry Fungus (N) S28-21.

G

Gatti, Raphael: *The Octopus—Eight Armed Enigma (diagram) N9-8; *The Deep Freeze—Absolute Zero (diagram) D14-9.
Glands (Salivary): *Thirst, Growth, and the Salivary Glands (Jacques Simmons) D7-10.
Gold: Red Sea Discovery (N) O5-19.

H

Hartline, Haldan K.: Nobel Award in Medicine (N) N16-18.

I

Ice Age: *Climates of the Past (diagram, John Speicher) O26-6.
Inventions: Flying Submarine (N) O12-14.

L

Ladybugs: Catch Aphids (N) S21-19.
Lansford, Henry H.: *Kingdom of the Saguaro O12-20; *Florissant's Fossil Treasures J18-16.

M

Magnets: *Superconducting Magnets (Michael Cusack) J18-11.
Marine Life: *Sea Creatures with Spiny Skins (Robert L. Wersan) O12-10; *Marine Research at Bodega Head (William Steele) D7-18.
Marsupials: Found in Australia (N) O19-13.
Measurements: *Big and Little (Simon Dresner) N30-10.
Medicine: Surgery with Calf Heart (N) S28-21.
Mendelevium: Heaviest Metal (N) O12-14.
Meteorites: *Harder than Diamonds? (diagram, Michael Cusack) O5-12.
Meteorology: W.M.O. Weather Project (N) N2-14.
Microbes: *Microbes at Work (John Speicher) O5-4; Microbes in Slow Motion (Alexander Joseph) J18-21.
Minerals: U.N. Proposal on Sea Bed Rights (N) O19-12.
Molluscs: *The Octopus—Eight Armed Enigma (diagram, Raphael Gatti) N9-8.
Moons: *Why Moons? (Michael Cusack) O12-7.
Muscles: *Muscle Power (John Speicher) O12-4.
Musk Ox: Musk Ox Wool (N) O12-15.

N

Neanderthal: *Neanderthal — Where Man Faced His Ancient Self (Ted Shoemaker) S21-20.
Nobel Prizes: Medicine (N) N16-18; Physics & Chemistry (N) N30-17.
Norrish, Dr. Ronald G. W.: Nobel Chemistry Award (N) N30-17.
Nutrition: More Power to You S28-40; Questions & Answers N16-37.

O

Ocean Currents: *Currents and Climates (Donald Sanders) O26-11.
Ocean Waves: *Surfing and Science (diagrams, Robert Wersan) N2-4.
Octopus: *The Octopus—Eight Armed Enigma (diagram, Raphael Gatti) N9-8.
O'Gorman, Samuel F.: *The Accident Plague O19-6.

P

Paper: New House (N) N9-13.
Parachutes: To Land Planes in Future (N) D7-17.
Phosphorus: *The Dead Sea (diagrams, Jacques Simmons) N16-6; *Phosphorus—Lethal Atom (diagrams, Michael Cusack & Carl Proujan) N16-15.
Photography: *Ultrahigh-speed Photography (diagram, Robert Wersan) N30-7.
Plants: *Kingdom of the Saguaro (Henry Lansford) O12-20; Weightless Growth in Space (N) N9-12; *Prospecting with Plants (Donald Sanders) J11-6; Plant Metabolism Without Light (Alexander Joseph) J11-14.
Poisons: *Phosphorus—Lethal Atom (diagrams, Michael Cusack & Carl Proujan) N16-17; *Poisons in Nature (John Speicher) D14-4.
Population: *Doomsday: 2026 A.D. (William Steele) N2-16.
Porter, Dr. George: Nobel Chemistry Award (N) N30-17.
Project Gasbuggy: Atomic Test for Natural Gas (N) O26-16.
Project Pointers (Alexander Joseph): Electricity and Plant Growth (diagram) S21-22; Vitamin B_{12} and Growth (diagram) S28-26; Cheese Microorganisms (diagram) O5-22; Biophysics of Muscle (diagram) O12-24; Migration of Na Ions Through Glass (diagram) O19-17; Weather and Life (diagram, Richard Harbeck) O26-20; Studying Climate (diagram) N2-20; Speeding Up Speech (diagram) N9-11; Electronic Noise (diagram) N16-22; High-Speed Photogra-

continued on next page

INDEX continued

phy (diagram) N30-15; Electrostatic Properties of Plastic (diagrams) D7-24; The Photodynamic Effect (diagram) D14-17; Plant Metabolism Without Light J11-14; Microbes in Slow Motion J18-21.

Proujan, Carl: *Phosphorus—Lethal Atom (diagram) N16-13; *The Rare Earths N30-8.

R

Rats: *Rats (Thayer Willis) S28-8.

Rockets: Saturn 5 Launched (N) D7-16.

S

Sanders, Donald: *Currents and Climates O26-11; Prospecting with Plants J11-6.

Senior Science Takes You There: Neanderthal: Where Man Faced His Ancient Self (Ted Shoemaker) S21-20; New Bolton Center—Hospital for Very Large Patients (Andre Harvey) O5-15; Kingdom of the Saguaro (H. H. Lansford) O12-20; Doomsday: 2026 A.D. (William Steele) N2-16; Porcupine Country (Irwin Ross) N16-16; The Laboratory of Tree-Ring Research N30-12; Marine Research at Bodega Head (William Steele) D7-18; Florissant's Fossil Treasures (Henry H. Lansford) J18-16.

Senses and Sensations: Animal Senses (N) O5-19; *The Senses—Still A Mystery (John Speicher) N16-10; Noise a Health Hazard (N) N30-17.

Simmons, Jacques: *Feedback (diagram) S21-6; *The Dead Sea (diagram) N16-6; *Thirst, Growth, and the Salivary Glands D7-10.

Sloth: *The Slowly Sloth (John Speicher) J18-8.

Smells: Fish (N) N30-16.

Solar Eclipse: 1970 Eclipse to be Tracked by Plane (N) O26-16.

Space: Lunar Orbiter 4 Report, Surveyor 4, Explorer 35 (N) S21-19; Surveyor 5 Moon Report (N) O12-15; Surveyor 5 (N) O26-16; Weightless Growth (N) N9-12; Mariner 5 & Venus 4 Report (N) N16-18; Russian Space Ship Docking (N) N30-16; Surveyor 6 Report (N) D14-12.

Speech: *The Speech Squeeze (diagram, John Speicher) N2-8.

Speicher, John: *How We Tell Time (diagram) S21-10; *Harvest of Hunger S28-16; *Microbes At Work O5-4; *Muscle Power O12-4; *Man Under the Sea O19-2; *Climates of the Past (diagram) O26-6; *The Speech Squeeze (diagram) N2-8; *Antibodies Lock and Key N2-11; *The Senses—Still A Mystery N16-10; *Waves in the Air (diagrams) D7-6; *The Malaria Menace J11-2; *The Slowly Sloth J18-8.

Surgery: Spinal Cord Surgery (N) D14-12.

T

Telescopes: British to Build World's Largest (N) N16-19; Project Stratoscope (N) D14-13.

Television: Best Color from Black and White (N) O19-13.

Temperatures: *The Deep Freeze—Absolute Zero (diagram, Raphael Gatti) D14-9.

Today's Scientists: Molitorisz, Joseph S21-16; Fehr, Dr. Uri S28-22; Appleman, Dr. Milo D. O19-14; Ewing, Dr. Maurice O26-18; von Sengbusch, Prof. Reinhold N9-14; The Sanitarian N16-18; North, Dr. Wheeler D14-14; Shipp, Dr. Kathryn J11-10.

Tomorrow's Scientists: Testing Reaction Time (Gary R. Roan) S21-24; Niacin (Nicotinic Acid) and Atherosclerosis (Judith Noll) S28-24; Color Changes in the Frog (George Kovac) O5-20; Tri-Color Vision (Dennis Watke) O12-26; Intelligence of Turtles (Rebecca Jones) N2-19; A Study of Lead-Zinc Alloys (John Files) N16-24; Chemical Protection Against Radiation (Antoinetta Capriglione) D7-22; Penicillin and Milk-Souring Bacteria (Deborah Sheets) J18-19.

TV Antenna: Pocket Size (N) O5-18.

V

Vaccines: To Fight Tooth Decay (N) O19-13; New Mumps Vaccine (N) N30-17.

Vacuums: *Search for the Perfect Vacuum (diagram, Robert Wersan) O5-8.

Viruses: *Hybrid Cells (Robert Wersan) S21-13; *Antibodies Lock and Key (John Speicher) N21-11.

Vitamins: Skin Color and Vitamin D (N) O5-10.

Volcanoes: *Volcanoes (diagram, Simon Dresner) S28-12; Mt. Kilauea Eruption (N) D7-17.

W

Wald, George: Nobel Award in Medicine (N) N16-18.

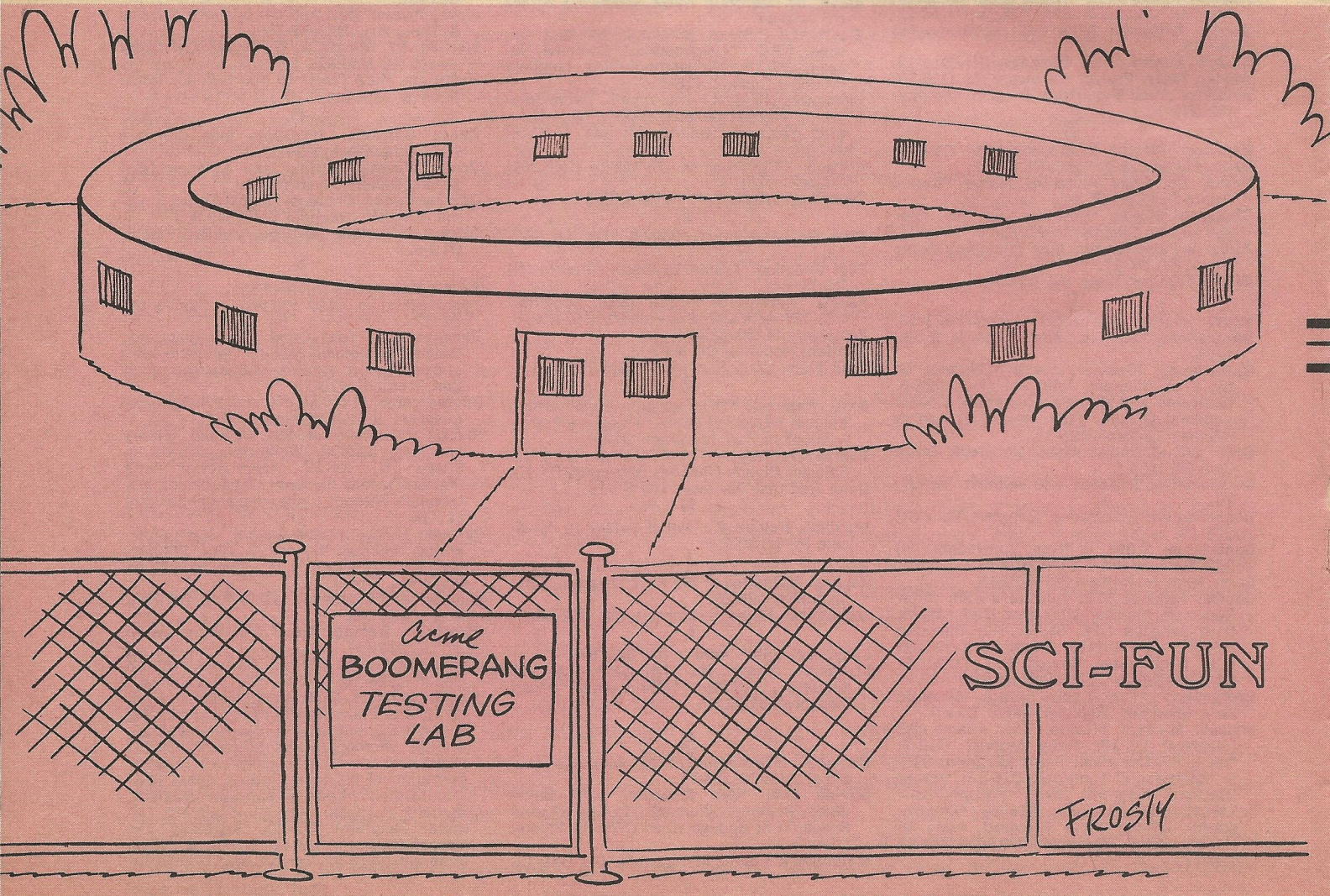
Water: Water Vapor Condensed for Dry Lands Project (N) N30-16.

Water Pollution: Torrey Canyon (N) S28-20; Missouri River Dye Test (N) D14-13.

Weather: see **Climatology and Meteorology.**

Wersan, Robert: *Hybrid Cells S21-13; *Search for the Perfect Vacuum O5-8; *Sea Creatures with Spiny Skins O12-10; *Surfing and Science (diagram) N2-4; *Ultrahigh-speed Photography (diagram) N30-4.

Willis, Thayer: *Rats S28-8; *What Is Death? N9-5.



Science on TV

Wild Kingdom

(Sundays, 7:00 p.m. EST, NBC-TV)

True stories of animals in the wild kingdom – including panthers in Venezuela, cougars in the Rocky Mountains, polar bears in the Arctic, giant anteaters in Africa, and leopards in India – highlight the new season of this award-winning series.

Weekly programs are hosted by Marlin Perkins, Director of the St. Louis Zoo, and Jim Fowler, internationally known explorer and ornithologist. Perkins described the new season's adventures in a recent interview: "We've been all over the map in recent months and have filmed some fascinating things," he said. "Jim and I are both zoologists and have had considerable experience in working with animals and with ecological problems around the world. We frequently work with conservation officials to tell the stories of what they're doing in their own communities. We don't contrive anything for the show or make things happen so we can film them."

Dive to Adventure, scheduled for Sunday, February 4, was filmed almost entirely under water in the Bahamas, where a device for attracting sharks was being tested. "We got inside a cage that was lowered to the floor of the ocean," Perkins recalled. "The shark caller was an electronic device that mimics the calls of distressed fish. Four of us were down there in that cage – and the sharks thought we were making the noise. They battered and bumped against the cage, but fortunately the bars held."

The series, according to Perkins, will feature different kinds of stories during the season. "Some of the shows will tell the life stories of certain kinds of animals – the cheetah, for example, which looks like a little puff ball when it's young (scheduled for February 11). We also went up to the Arctic to film the animals of the north country. On one trip up there we got lost in the fog and it took the Eskimos who were running our boat eight hours to find shore."

Perkins says other episodes will be "action shows" – the relocation of baby elephants in Africa, a visit to one of the world's largest bird sanctuaries on the island of Raza off the coast of California, and an expedition to three islands in the Pacific. "We want to show how animals live and what is being done to protect them," Perkins added.

– Peggy Hudson

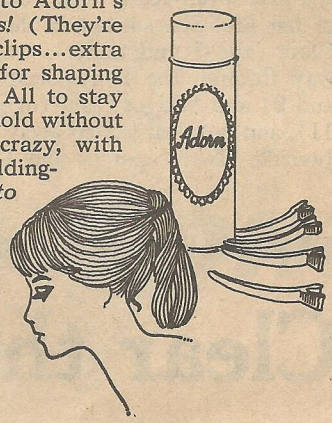
Teens ask Toni ...

Q. *One slalom—and my flip's down and out! How can I zing it up for after-ski parties? G. N., Barre, Vt.*

A. Best way to cope with ski-slope slump: Give your hair the "bracer" it needs—*before* you ski. Namely, body. The basic body you get with a Toni. It's what gives hairdos shape; holdability. Helps keep snow-happy flips fizzle-proof—longer than a mere set can. What's more, no constant setting's needed. (Remember, this body is the *permanent* kind!) Try UNcurly Toni. Brace up your ski 'do with basic body and say skiddoo to limp locks. With the flick of a comb they'll make a quick come-back: be smooth as a schuss...springy as a gelände-sprung!

Q. *Come date time, can I possibly make my long plain hairdo look "big-time"?? L. R., Tampa, Fla.*

A. Merely colossal! Once you're hip to Adorn's g-r-e-a-t new styling-mates: *Colossal Clips!* (They're *free* with Self-Styling Adorn!) Giant-size clips...extra long, to hold BIG sections of hair. Terrif for shaping bangs, supah flips, curves, what-have-you! All to stay colossally smooth—because Colossal Clips hold without ridges. Of course, your style holds like crazy, with Adorn, the *waterfree* hairspray. (It's the holding-est!) You can swoosh *this* spray right *into* your hairdo—not just on top! Today, grab yourself some Adorn. Get four "Colossals" and six "big-time" styling tricks—colossally free! Then glamorize your long, tired locks this easy way:



1. You do it with Adorn and four Colossal Clips. First, gather hair into ponytail.

2. Part off ponytail into three layers. Feather top layer, and spray with Adorn. Then brush feathered hair up over your fingers into a forward roll.

3. Fan roll over crown and clip at each end. Repeat with second layer. Turn remaining layer under and bobby-pin to nape of neck. Spray with Adorn.

4. You've turned your plain mane into a crown! Just replace Colossal Clips with hairpins. Waterfree Adorn does the *powerful* holding!

Any questions about hair care? Write Carol Douglas, The Toni Company, Box 3600, Chicago, Illinois 60654. Include your name and address.

SPORTS

Sue-preme on Skates!

THE city of Detroit these days is not only tooling the fastest things on wheels, but is forging the fastest "thing" on skates. The Detroit Speed Skating Club has been working on this "model" for several years, and the public is beginning to buzz about it. It has great lines, great speed, and great beauty.

We're talking about 14-year-old Sue Carol of Dominican High School. Maybe not in 1968, but definitely by 1972, Sue is going to do something about winning an Olympic speed skating gold medal for Uncle Sam.

Sue has been burning up the ice for the past seven years. That's exactly half of her life! She started in the Toddler Class (age 7 and under), worked her way through the Pony Class (ages 8 and 9) and Midget Class (ages 10 and 11), and last year skated away from the Juvenile Class (ages 12 and 13).

Her school and the Detroit Speed Skating Club are mighty proud of their whippet on skates. She's a flyer in every distance from 220 yards to a half mile. Last year she won six championships, including the Michigan State, Midwest, and Canadian Indoor titles.

Sue also holds six state records in the Midget and Juvenile classes. What's more, her Juvenile 440-yard mark is tops for the whole country! All in all, she has won 56 first-place trophies and 65 medals for second, third, and fourth places.

Though the word "Juvenile" makes you think of smallness, Sue is anything but. She stands 5-feet-5 and weighs 110 pounds. Built for speed and power, she cuts a pretty picture on the ice with her long, silky blonde hair, blue eyes, sweet face, and radiant smile.

Behind every young star usually stands an encouraging parent. And in Sue's case, it's her father. He got her interested in speed skating and still coaches her. He started her out as a Toddler at age 7, and she took to the ice the way an eagle takes to flying. For the past five years, she has been the top skater in her class.

Like most great athletes, Sue practices her sport all year round – in the summer as well as the winter. But she also finds time to do a lot of other interesting things. She's a fine tap dancer and guitar player, and is crazy about baseball.

Sue's other "favorites" line up as follow: actress, Mia Farrow; actor, Elvis Presley; band, Paul Revere and the Raiders; singers, Simon and Garfunkel; and school subject, math. Her big ambition in life is to make the U.S. Olympic Team. Detroit is rooting for her.

Clear the Track

AS YOU probably know, 1968 is an Olympic year, and all our experts are now sporting stop-watches and tape measure. They're trying to figure out whether our runners, jumpers, and throwers will be good enough to win in Mexico City next fall.

As usual, about 99 per cent of our track team will come from the colleges and open classes. One, two, or maybe three athletes will come right out of our high schools. Who will these lucky (and talented) boys be?

Our hunch is that they'll come from the sophomores and juniors who made *Scholastic Magazines'* 1967 All-American H.S. Track Team. Here are these great young athletes, together with their best 1967 marks:

880-Yard Run: Dave Fox, Senior, Wapato (Wash.) H.S., 1:51.9.

330-Yard Hurdles: Bob Bornkessel, Senior, Shawnee Mission (Kan.) North H.S., 38.2.

Triple Jump: Ty Cunningham, Senior, Gompers H.S., New York City, 48-5¾; and Chuck Steffes, Senior, Sunnyvale (Calif.) H.S., 47-5.

Long Jump: Al Dyson, Senior, Mt. Hermon (Mass.) H.S., 24-4.

High Jump: Reynaldo Brown, Junior, Compton (Calif.) H.S., 6-9¼; and Joe Mackey, Senior, Coronado H.S., Scottsdale, Ariz., 6-9½.

Pole Vault: Casey Carrigan, Junior, Orting (Wash.) H.S., 15-4.

Shot Put: Doug Lane, Senior, Jefferson H.S., Cedar Rapids, Iowa, 67-1.

Track experts will immediately spot the fact that none of these marks comes up to Olympic standards. But you have to remember that all of them were made a year ago, and high school athletes improve like crazy from one year to the next.

We're not claiming that our All-Americans *will* make the team. We're just saying that they have the best chance to do so.

Probably the greatest feat ever accomplished by a high school athlete was turned in by Bob Mathias in the 1948 Olympics. He won the decathlon event – the toughest on the Olympic calendar – while a student at Tulare (Calif.) H.S.! And when he won his second crown four years later, another schoolboy – Milt Campbell of Plainfield (N.J.) H.S. – finished right behind him.

Strange isn't it, that high school track athletes can only win the *toughest* event in the Olympics. *You* figure it out!

–HERMAN L. MASIN, *Sports Editor*

ANSWERS ON PAGE 24

brainteasers

Easy as 1, 2, 3

Utilize the digits 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0 so that they will equal 100.

3 5 1

6 9 7

8 2

4 0

Each digit must be used once, but only once. This one is not easy.

John Hicks
McClintock H. S.
Tempe, Ariz.

Taxing?

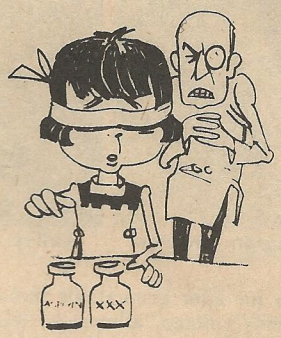
Alfred bought a television set for $126.63. The price included a 5 per cent sales tax. What was the price of the TV set without the tax?

Richard Miccio
St. Vincent Ferrer
Brooklyn, N. Y.

Do you have a favorite brain teaser? Send it to Senior Science, 50 West 44th St., New York, New York 10036. We will pay five dollars for each one published. Include the name of your school, home address, grade, and age. In case of duplicate submissions, choice will be made on the basis of presentation and clarity.

Prince and the Pill

The Proud Prince is in deep trouble again. Held captive by the Cruel Count, the prince must risk death for a chance at freedom. The Count shows the Prince two jars of pills. One contains 10 poison pills, the other 10 aspirin. The Prince may arrange the pills in the jars in any manner he wishes. Then, blindfolded, he must select at random one pill from one of the jars and swallow it. If he lives, he is free. If he dies, this magazine will present no more brainteasers about the Proud Prince.



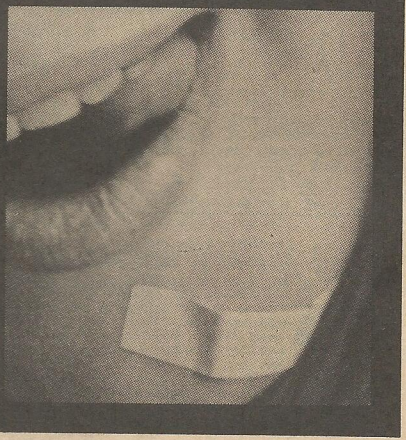
Our hero faces a great risk, but he can minimize it so that his chances for survival are quite good. Can you describe how the Prince should allocate the pills? What will his chances of selecting an aspirin be?

Neil Shay
Tomlinson Jr. H. S.
Fairfield, Conn.

Editor's Choice

Consider a cup of tea and an equal amount of coffee in another cup. Suppose that you remove a teaspoonful of tea and put it in the coffee. Then you remove a teaspoonful of the coffee/tea mixture and return it to the tea. These exchanges are repeated four more times — five in all. When you are finished, will there be more tea in the cup that was originally all coffee, or more coffee in the cup that was originally all tea?

Just smile and they'll never notice that blemish on your chin.



C'mon.

You don't believe that.

And if *they* don't notice it, *you* do.

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DISC-USSIONS
THE BEST OF THE NEW LPs

BY ROY HEMMING
with Robin McBride, Ed Coach, Buzz Royden

JAZZ ALBUM OF THE WEEK **Duke Ellington—The Beginning** (Vol. 1, 1926-28) [*Decca DL9224*]. Let's make one point clear at the start: this reviewer believes staunchly that Duke Ellington is the single greatest creative musician the U. S. has yet produced (and I'm not forgetting Gershwin, Ives, Rodgers, Bernstein, and lots of others, either). Whether writing hundreds of simple songs, extended jazz works, or symphonic tone poems over the past 40 years, Ellington's melodic inspiration has been truly unique. And he has coupled this with a real "feel" for and an understanding of a natural American musical idiom. What is particularly gratifying, historically, is that Ellington has been so extensively recorded over the years with his own orchestra—most recently for RCA Victor, Verve, and Reprise. Meanwhile, his early work (from the 1930's and 1940's) has also been kept

Ellington: greatest

Bailey: just right

alive for later generations through several superb "vintage" albums on RCA and Columbia. Now Decca has delved into its vaults for some of the earliest of all Ellington material (which it acquired several decades ago when it took over the Brunswick label and has never previously re-released). The sound and arrangements of these 1926-28 cuts by Ellington's Kentucky Club and Cotton Club bands may be plainly dated, but the musical ideas are still fascinatingly Ellingtonian. Especially interesting are the original versions of "Black and Tan Fantasy," "East St. Louis Toodle-oo," and "Black Beauty." (R.H.)

ALBUM OF SPECIAL INTEREST **Hello, Dolly!—Pearl Bailey, Cab Calloway & New Broadway Cast** [*RCA Victor LSO-1147*]. *Dolly* has been running strong on Broadway since 1963—first with Carol Channing, then with Ginger Rogers, Martha Raye, and Betty Grable. But the newest *Dolly* star, Pearl Bailey, has so flipped Broadway critics and audiences that RCA has re-recorded the show's score with the latest cast. What gives this new version additional significance is that the cast is all-Negro—and that it plays *Dolly* straight (in contrast to earlier all-Negro Broadway productions of *The Hot Mikado* and *Carmen Jones* which "adapted" the original material to fit certain Negro musical stereotypes). The new LP proves how beautifully *Dolly* works whatever the hair color, eye color, or skin color of its players. Miss Bailey has just the right crusty warmth for the Yonkers matchmaker—and she sings "Before the Parade Passes By," "So Long Dearie," "Motherhood," and the title song with more good humor and style than anyone since the original Channing. The rest of the cast performs Jerry Herman's still-delightful score with great spirit—particularly Cab Calloway as "Horace." And Emily Yancy sings the show's best ballad, "Ribbons Down My Back," better than *anyone* ever has. (R.H.)

POPULAR ALBUM OF THE WEEK **With a Lot o' Soul—The Temptations** [*Gordy 922*]. One forgets how fantastic the Temptations are until you hear their renditions of "All I Need" and "You're My Everything" in stereo. There are 10 other cuts on this LP, and they all swing with some of the grooviest soul-filled sounds yet out of Detroit. The Temptations remain in a class by themselves for that fully orchestrated, soul group-sound that insists you dance, listen, and enjoy. (R.M.)

Respect—Jimmy Smith [*Verve V6-8705*]. The pulsating, rocking beat of Smith's organ is especially fine in this rhythm and blues context. Top cuts are "Respect" and "Funky Broadway." Smith transmits few deep or far-out thoughts, just good fun, good jazz, good dance music. (R.M.)

Basie's in the Bag—Count Basie Orchestra [*Brunswick BL-754127*]. This bag is supposed to be for "the kids of today," to quote the liner notes. Mebbe so. But it's silly to put *any* age level on such a big, swinging, happy blaze of foot-tapping sound. The great Basie rhythm section and brass rip brightly through a dozen up-tempo tunes. The Count-down, as always, is terrific. (E.C.)

CLASSICAL ALBUM OF THE WEEK **Dawson: Negro Folk Symphony—Leopold Stokowski, American Symphony Orchestra** [*Decca DL-10077*]. Composed in 1932 and premiered by the Philadelphia Orchestra under Stokowski two years later, this was one of the first major works by a U. S. Negro composer in a strictly symphonic, non-jazz form to win critical acclaim. Dawson himself (music director of Tuskegee Institute in Alabama for 25 years) remained dissatisfied with parts of the symphony, and revised it in 1952. It is the new version Stokowski plays here. Although it employs its folk themes in a conservative, often rambling manner, the work is most appealing—especially the second movement ("Hope in the Night"), which might even make a superb tone poem on its own. (B.R.)

BUY U.S. SAVINGS BONDS

FOLLOWING THE FILMS

SMASHING TIME
(Paramount)

When Brenda (Rita Tushingham) and Yvonne (Lynn Redgrave) get off the train at St. Pancras Railway Station, the citizens of London would do well to head for the nearest bomb shelter. The two girls have come to the big city to seek their fortunes. But when they go home again, swinging London has been brought to a standstill.

Brenda and Yvonne roll through town like driverless tanks. Whatever they touch seems to turn into a shambles. Brenda goes to work in a workingman's cafe, and almost at once spray cans are covering everything with multi-colored goo. Yvonne becomes a waitress in an "In" restaurant, and pies begin to fly in every imaginable direction. The "pad" they rent is demolished by a TV program team that specializes in making audiences laugh at the misfortunes of others. Yvonne is photographed for a newspaper, but when the photo is published, the caption reads "Skirt the right length, but the wrong legs. Will this style ever come back? Let's hope not!"

Although there is more slapstick in *Smashing Time* than Mack Sennett ever dreamed of, there is also some pretty pointed satire on the pop culture of today in which lack of talent is no barrier to fame and fortune. In this Alice-in-Wonderland climate, it is not at all surprising when tone-deaf Yvonne becomes a top recording "artist," and plain Brenda is turned into the Model of the Year. But it is hilariously gratifying when these two symbols of the '60's cut out, happily unaware that they have almost wrecked the town that made their phony success possible.

DR. DOLITTLE
(20th Century-Fox)

Once upon a time, during World War I, a British soldier huddled in a trench in France and wrote letters to amuse his children in the far-off U.S. The letters were not concerned with battles or bloodshed. Instead, they told of the adventures of a Dr. Dolittle who could talk to animals.

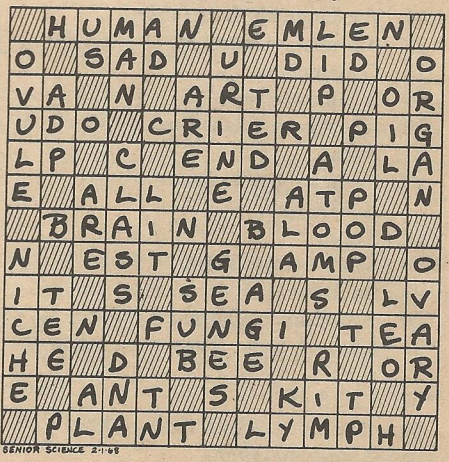
When the war ended, Dr. Dolittle began a long and successful career. The British ex-soldier, whose name was Hugh Lofting, went on to write 12 best sellers for children everywhere about the fabulous physician and his animal friends. The secret of Dr. Dolittle's enduring success as a literary character lies in Lofting's attitude toward his readers. He respected them and never wrote down to them. "Whenever a book is a real success for children," he once said, "it is also a success and an enjoyment for adults."

It is too bad that those who decided to turn Hugh Lofting's books into a super film ignored his philosophy. They produced a cute, cuddly, Technicolor spectacle for children of 7 or 70. But moviegoers who don't fit into these two categories, and that includes teenagers, are likely to find that *Dr. Dolittle* does little for them.

The best thing about this film is Rex Harrison, and he is very good indeed. He's the next best thing to a cure for the common cold when he chats with a fox about her children, defends himself in court against a lunacy charge, and sings romantic nonsense to a seal in a bonnet. When Harrison is onscreen, the audience forgets to ask such questions as: Why isn't there more of Harrison and less of Anthony Newley? Why are the songs, for the most part, so tedious and so familiar-sounding? Why is a good dramatic actress like Samantha Eggar wasted in a part that shouldn't be in the film anyway? Why couldn't the skilled technicians in the special effects department come up with a Great Sea Snail that looked less like an overgrown bathtub toy?

— MARGARET RONAN

ANSWERS TO PUZZLE
(see page 24)



Scorekeeper
(see page 16)

I. Mystery of the Earth's Spin
1.F; 2.T; 3.T; 4.F; 5.T; 6.T; *7.T.

II. Today's Scientists
1.F; 2.T; 3.T; 4.F; *5.T.

III. Critical Issues in Science
1.T; 2.F; 3.T; 4.F; 5.T; *6.T.

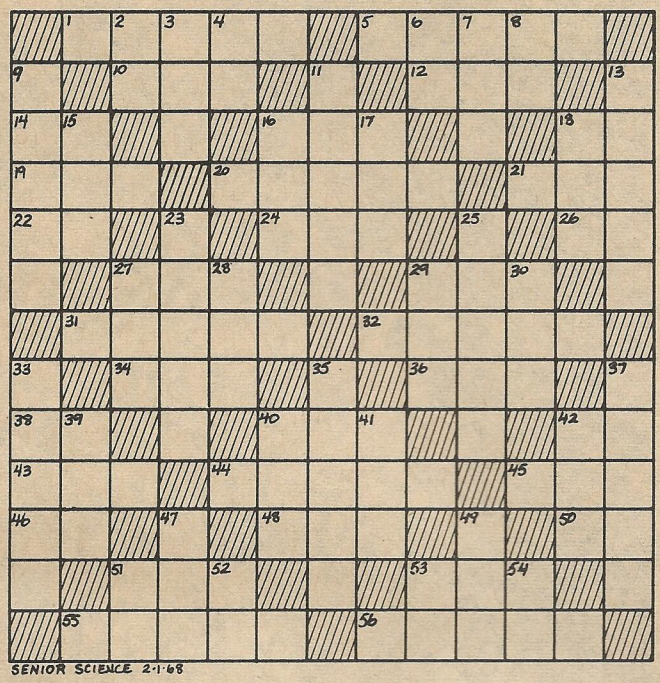
IV. How Fish Hear
1.T; 2.F; 3.F; 4.F; *5.F; *6.T.

Biology Box

By Kirk Swezey, Cubberly H. S., Palo Alto, Calif.

★ **Starred words refer to biology**

Students are invited to submit original crossword puzzles for publication in *Senior Science*. Each puzzle should be built around one topic in science, such as astronomy, astronautics, botany, geology, electronics, famous scientists, etc. Maximum of 50 words, of which at least 15 must be related to the theme. For each puzzle published we will pay $10. No entry will be considered unless it includes all of the following: symmetrical puzzle design and design with answers filled in, definitions, answers on separate sheets, and a statement by the student that the puzzle is original and his own work. **Puzzles must be symmetrical.** Keep a copy, as puzzles cannot be returned. Give name, home address, school, and grade. Address: Puzzle Editor, *Senior Science*, 50 West 44th Street, New York, N. Y. 10036. Answers to this puzzle are on page **23**



ACROSS

1. Person.
5. Man's name *(rare)*.
10. Unhappy.
12. Accomplished.
14. Washington's State *(abbr.)*.
16. A branch of learning.
18. Conjunction.
19. A Japanese herb.
20. One who proclaims orders of a court.
21. Swine.
22. Term applied to record played at 33⅓ rpm.
24. Finish.
26. San Francisco's rival *(abbr.)*.
27. Each one.
*29. Adenosine triphosphate *(abbr.)*.
*31. Mass of nerve tissue enclosed in the skull.
*32. Life fluid.
34. Eastern Standard Time *(abbr.)*.
36. Amperage *(abbr.)*.
38. Pronoun.
40. Ocean.
42. Leave *(abbr.)*.
43. Century *(abbr.)*.
*44. Plants with spores.
45. Accompanies crumpets.
46. This man *(pronoun)*.
48. Honey maker.
50. Either, _____.
51. Wingless insect.
53. Catherine's nickname.
*55. It carries on photosynthesis.
*56. Lymphatic fluid.

DOWN

2. Our country *(abbr.)*.
3. Adult male human.
4. Advertisement *(abbr.)*.
6. Home State of Naval Academy *(abbr.)*.
* 7. Edge of the mouth.
8. Prepare for publication *(abbr.)*.
* 9. Egg in early stage of growth.
*11. Fluid excretion from the kidneys.
*13. The eye is one.
*15. Adenosine diphosphate *(abbr.)*.
16. Form of *to be*.
17. To spread or scatter for drying.
18. Petroleum.
*23. Between phylum and order.
*25. Building blocks of nature.
27. Same as No. 16 Down.
28. Lighted.
29. Gov. Wallace's State *(abbr.)*.
30. Mom's husband.
33. A recess in a wall.
*35. Transmit inherited characteristics.
*37. Female reproductive organ.
39. Golf ball holder.
40. Underwater boat.
41. To grow old.
42. A sign of the zodiac.
*47. Deoxyribonucleic acid *(abbr.)*.
49. Outer edge of a wheel.
51. Aluminum *(chem. sym.)*.
52. Ton *(abbr.)*.
53. Boone's State *(abbr.)*.

ANSWERS TO BRAIN TEASERS

(see page 21)

Easy as 1, 2, 3

$49\frac{1}{2} + 50\frac{38}{76} = 100$.

Taxing?

If X represents the price of the TV set alone, X + 5 per cent of X, or X + 1/20X = 126.63. Then 21/20X = $126.63. X = $120.60.

Prince and the Pill

Our resourceful Prince will place one aspirin in one jar and all 19 other pills in the second jar. If he selects his pill from the first jar, it is sure to be an aspirin. If he selects from the second jar, his chances are 9 out of 19 that he will get an aspirin. His combined chances of selecting an aspirin are 28 out of 38. With those odds, the Proud Prince should live on.

Editor's Choice

When you have completed the exchanges there will be equal amounts of liquid in the two cups, just as when you started. Thus, the amount of tea in the original coffee cup must equal the amount of coffee in the original tea cup. Whatever amount of coffee has been removed from the original coffee cup has been replaced, since it contains the same amount of liquid as at the start. Thus, the coffee removed has been replaced by an equal amount of tea.

CARE U.S.A.

JOB OPPORTUNITIES IN STEEL

As a high school graduate, you may ask: "Is there a place for me in the iron and steel industry?" The answer is yes—if you have energy, common sense, and the desire to get ahead. "Opportunities In Steel," published by Scholastic Magazines in cooperation with the American Iron and Steel Institute, outlines job opportunities in this dynamic industry. To order your copy of this informative paperback, send 35¢ in coin (no stamps, please) to: **Scholastic Book Services, 904 Sylvan Ave., Englewood Cliffs, N. J. 07632.**

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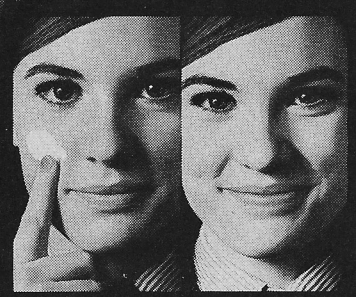
New White Vanishing Formula

Now, famous Flesh-Tone Clearasil has a NEW "out of sight" companion that helps keep skin problems out of mind.

Works just like Flesh-Tone, only invisibly. Use it as directed. All over your face and extra on blemishes.

Time, discipline, and serious blemish medicine is the way to clearer skin. And Clearasil is serious blemish medicine. It works fast to help clear today's blemishes. And drinks up excess oil that may cause tomorrow's problems.



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New White Vanishing Clearasil works invisibly.

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